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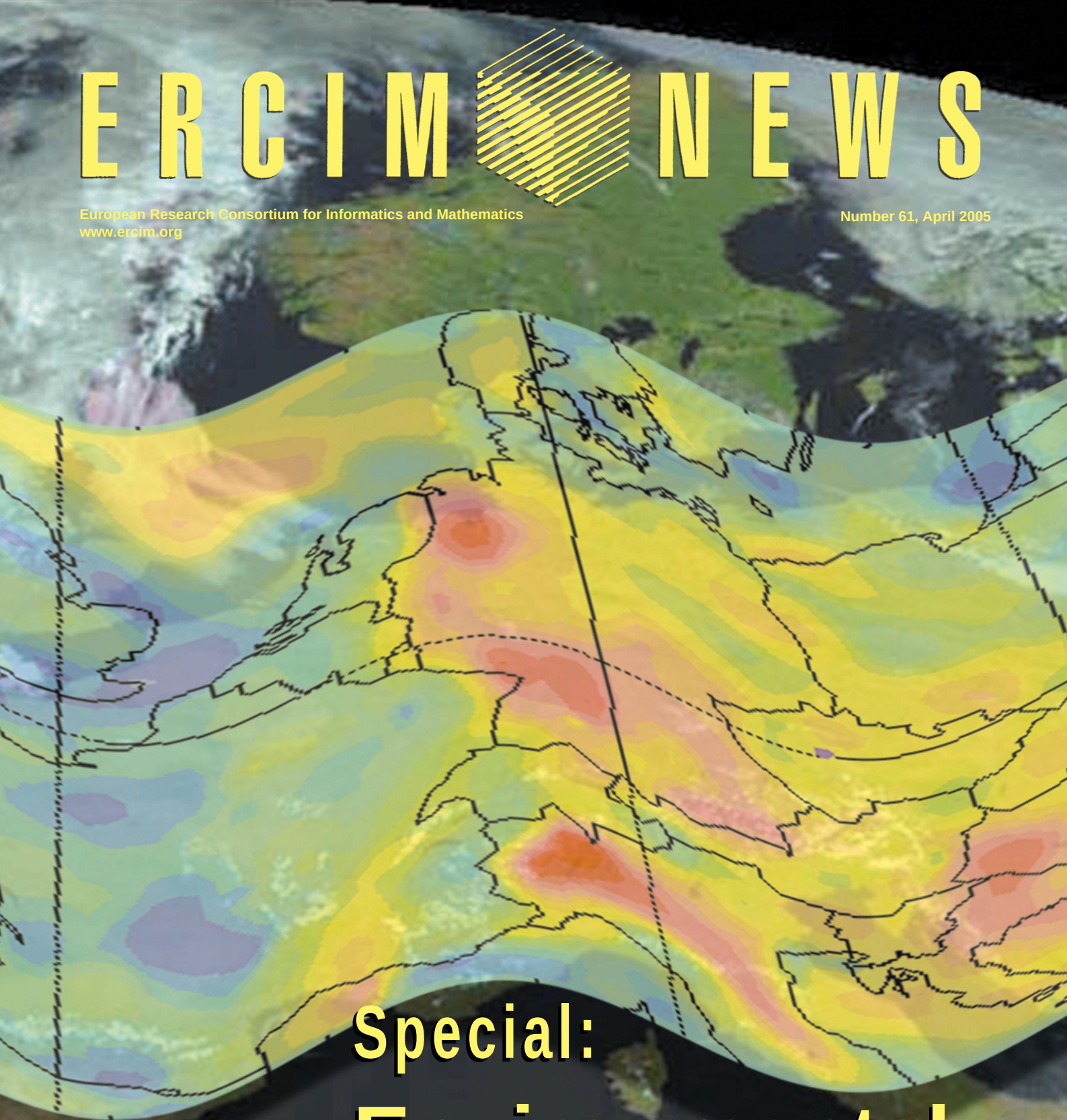

Special: Environmental Modelling

CONTENTS

Next issue: July 2005

Special theme: Multimedia Informatics

Walter R. Erdelen
Assistant Director-General
Natural Sciences Sector
UNESCO

Modelling is an essential tool in the scientists' kit that allows them to indulge in their favourite pastime, ie, trying to understand reality. I am convinced that not many scientists would claim that an absolutely accurate simulation of even little bits of reality is an easy task. Yet, modelling enables the scientist to interact iteratively with reality, continuously testing the assumptions used to build models against the extent to which model predictions match reality.

Environment, however, is a complex subject. It can be studied from a variety of disciplinary perspectives ranging from the physical to the sociological. Single-disciplinary experts attempting to describe reality at the human-environment interface is like the four blind men trying to imagine the shape of the elephant by touching different parts of the animal's body. When decisions for positive human-environment relations must be based upon integrated multidisciplinary data and knowledge, modelling becomes an indispensable skill and tool.

Interdisciplinary collaboration among scientists is a hallmark of all UNESCO's environmental sciences initiatives, which all use modelling frequently to address scientific as well as policy questions at the human-environment interface. The Man and the Biosphere (MAB) Programme in particular has promoted interdisciplinary collaboration for understanding environmental issues and problems for over 30 years. Teams at UNESCO's International Centre for Theoretical Physics (ICTP) build models to visualize global climate change scenarios; this Centre has served as an incubator for ecological and environmental economists who have used modelling approaches to understanding natural resource use and management conflicts worldwide. ICTP organizes training workshops that promote the use of quantitative methods, including specialized disciplines like mathematical ecology, that are essential to mastering environmental modelling techniques.

Using model predictions in a guarded and precise manner is part of the scientific integrity of modellers. Where environmental issues have entered the political mainstream it is not always easy to separate advocacy prescriptions from rigorous scientific interpretation of model predictions. In recent years climate change predictions have been largely based on scientific models, but such predictions are used not only by modellers or scientists. A wide range of advocacy groups have interpreted model predictions and may have contributed to widespread disagreement about those decisions and actions that nations, businesses and civil society must pursue to reverse or stabilize current climate trends.

As modelling becomes a tool increasingly used to provide scientific insights into solving environmental puzzles, concern about the level of awareness of policy and decision makers, the general public and politicians is growing. To what extent are those who will set policy and influence decisions for the implementation of important environmental agreements aware of the strengths and weaknesses of modelling? How many of them have the background and curiosity to check the assumptions of models against the validity of interpretations given to model predictions?

I hope that groups like ERCIM will not only advocate for greater application of modelling approaches to studying and understanding environmental issues; I would also like to invite them to consider working with organizations like UNESCO, particularly during the newly launched UN Decade of Education for Sustainable Development, to build skills and competencies among decision makers and the public, for a better appreciation and awareness of modelling methodologies and approaches, their constraints and strengths, and the intricacies of interpreting model outcomes into policy prescriptions.

In Memory of Stelios C. Orphanoudakis

It is with deep sadness that we learnt of the untimely death of Stelios C Orphanoudakis, former President of ERCIM, on 18 March 2005.

Professor Stelios C. Orphanoudakis was Director of the Foundation for Research and Technology Hellas (FORTH) and Chairman of its Board of Directors. He was Director representing FORTH (and Greece) on the ERCIM Board of Directors since 1992, when FORTH joined ERCIM as the seventh member. He was vice-president of ERCIM from 1994 to 2003, and President from January 2004 until October 2004, when he resigned due to illness.

In a distinguished academic career, he obtained a Ph.D. degree in Electrical Engineering from the Thayer School of Engineering, USA, an M.S. degree in Electrical Engineering from the Massachusetts Institute of Technology (MIT), and a B.A. degree, magna cum laude with highest distinction in Engineering Sciences, from Dartmouth College. Since 1986, he held a faculty appointment as Professor of Computer Science at the University of Crete. Furthermore, from 1991 until 1994, he was Acting Director of the Institute of Computer Science of FORTH (ICS-FORTH) and, from 1994 until 2004, he was Director of this Institute. At ICS-FORTH, he was the inspirational scientific leader of the Centre for Medical Informatics and Health Telematics. He held a faculty appointment in the Departments of Diagnostic Radiology and Electrical Engineering at Yale University, USA, from 1975 until 1991.

Prof. Orphanoudakis was a member of many honorary and professional societies and a Senior Member of the Institute of Electrical and Electronic Engineers (IEEE). He dedicated many years of teaching and research to the fields of computational vision and robotics, intelligent image management and retrieval by content, medical informatics, and medical imaging. He authored more than 120 publications in international scientific journals, refereed conference proceedings and books. He served on various committees and working groups of the European Commission and was active in numerous European R&D programs. He also served on the Board of Directors of the EuroPACS society (1994 - 2000). During the period 1995-2000, he served on the National Telecommunications and Post Commission of Greece. Finally, from 1994 until 2001, he served on the National Advisory Research Council of Greece and, from 1998 until 2002, he served on the Board of Directors of the Hellenic Foundation for Culture.

Prof. Orphanoudakis was a fervent advocate of multidisciplinary research approaches and of international research cooperation. He deeply believed in the potential of ERCIM to promote and advance scientific research in Europe, and was actively committed towards the achievement of this objective. We all recall his energy and enthusiasm, his vision for the future of ICT - especially in healthcare - and his professionalism. Simultaneously, we recall his warmth and friendliness, his hospitable nature and his memorable personality. He was an excellent ambassador for FORTH, his scientific discipline, his country and ERCIM. He will be much missed by all his colleagues and friends.

The FORTH announcement is available at:
http://www.forth.gr/press-releases/orphanoudakis_press.html

Keith G Jeffery, President

ERCIM PhD Fellowship Programme

ERCIM offers 18-month fellowships in leading European information technology research centres. Fellowships are available for PhD-holders from all over the world.

Conditions

Applicants must:

- have a PhD degree or be in the last year of the thesis work
- be fluent in English
- be discharged or get deferment from military service
- start the grant before October 2005
- have completed their PhD before starting the grant.

Fellowships are usually spent in two ERCIM insitutes. The fellow will receive a monthly allowance which may vary depending on the country. In order to encourage mobility a member institute will not be eligible to host a candidate of the same nationality. Further, a candidate cannot be hosted by a member institute, if he or she has already worked in this institute for a total of 6 months or more, during the last 3 years.

ERCIM does not only encourage researchers from academic institutions to apply, but also scientists working in industry. In order to encourage the mobility, a member institution will not be eligible to host a candidate of the same nationality.

The programme focuses on topics defined by the ERCIM working groups and projects administrated by ERCIM. However, applications are also welcome for other areas in which ERCIM institutes are active.

Deadlines

Next deadlines for applications:

- 30 April 2005
- 31 September 2005.

More information:
Detailed information, conditions and online application form is available at:
http://www.ercim.org/fellowship/

ERCIM Working Group on Security and Trust Management

by Fabio Martinelli

ERCIM's board of Directors approved a new Working Group on Security and Trust Management in January 2005.

The new ERCIM WG on security and trust management (STM) aims at fostering European research and development in the field of security, trust and privacy in information and communication technologies (ICT). The pervasive nature of emerging ICT has added new areas of concern to the information security area. Additional problems are posed in terms of new potential attack scenarios, threats, menaces and damage. The increased virtual and physical mobility of users enhances their possibilities for interaction but leads to an increasing demand for the reliable establishment of trust relationships. Privacy is also a main concern in the current ambient intelligence paradigm: wherever there are devices interacting with users it is possible that such devices are also gathering information about the users. These problems and many others are being perceived at different levels of concern by users, technology producers, scientists and governments.

The STM WG has been established considering that:

- Most ERCIM partners have acknowledged the importance of 'security and trust' by establishing research groups on this theme. These groups often study similar topics. Co-operation between these groups would strengthen their research capabilities.
- Security and trust management does not play an essential role in the current ERCIM working groups in force. A new working group should achieve maximum synergy among the partners in this area and create a critical mass for research and scientific visibility.
- Current international funding opportunities often require large consortia. A working group could play a pivotal role in establishing consortia in which ERCIM partners play a role.
- Mobility of researchers is essential to bring both individual researchers and research groups to a higher level. A working group would be beneficial in facilitating this.

The STM WG is committed to a series of activities including joint research work, project proposals, event organization, mobility of researchers and others. In particular, the joint research and dissemination activities will have the following objectives:

Research and Technology

- to investigate the foundations and applications of security and trust in ICT
- to study the deep interplay between trust management and common security issues such as confidentiality, integrity and availability
- to identify and promote new areas of research connected with security management, such as dynamic and mobile coalition management (e.g., P2P, MANETs, Web/GRID services)
- to identify and promote new areas of research connected with trust management, e.g. reputation, recommendation, collaboration etc
- to provide a platform for presenting and discussing emerging ideas and trends.

Education and Dissemination

- to promote the growth of young researchers interested in the field of security
- to support and stimulate the organization of meetings and events related to research issues in security and trust management
- to provide a forum for the exchange of expertise and information also with industry
- to increase public awareness on issues related to information security.

The research activities of the WG will be mainly focussed on:

- rigorous semantics and computational models for security and trust
- security and trust management architectures, mechanisms and policies
- networked systems security
- privacy and anonymity
- identity management
- ICT for securing digital as well as physical assets
- cryptography.

Other Activities

One of the main objectives of the STM WG is to provide a means to participate in joint research projects that span national borders. One main source of possible funding will be EU research programmes. In particular, the scope of the WG exactly matches several objectives in FP6 (calls 4/5) and FP7. The great attention paid by EU to 'security' in a broad sense is shown by the specific research funding programmes on security (eg, see http://www.cordis.lu/security/ and the recent Preparatory Action on 'The enhancement of the European industrial potential in the field of Security Research' (PASR 2004)). The STM WG is also strongly committed to stimulate mobility, enabling work on collaborative research projects at other institutes for short periods. Moreover, the STM WG has identified new topics of interest to be included in the ERCIM Fellowship Programme. The STM WG will organize a thematic workshop each year.

Membership

We encourage the active participation of researchers from both ERCIM and non-ERCIM research institutions and from industry.

Link:
STM WG Web page:
http://www.iit.cnr.it/STM-WG

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Strategic IST-FET / NSF Workshops organised by ERCIM on the 'Disappearing Computer' and on 'Unconventional Programming Paradigms'

ERCIM has just published two reports on the workshops 'The Disappearing Computer' and 'Unconventional Programming Paradigms' as part of the strategic workshop series under the auspices of the European Union (Information Society Technologies — Future and Emerging Technologies action) and the US National Science Foundation (Computer and Information Sciences and Engineering division).

The Disappearing Computer

The strategic research workshop on 'The Disappearing Computer' was organised in Vienna, on 24 April 2004. The event was designed to present and discuss visions, key research challenges and future R&D directions in the area of the disappearing computer and ubiquitous computing. About 20 leading experts from Europe and the United States participated in the workshop, representing perspectives from academia and research institutes as well as industry labs and consulting.

Computers are with us everywhere and we are aware of their increasing significance for our lives. Still, we are only beginning to accept that the increasing ubiquity of computers and related devices and their diffusion into our environment demands a rethink of the complex interplay between people and technology. In line with this, a number of themes emerged from the workshop. They cover basic technology and infrastructure issues, the role of sensors and the pressing issues of privacy and security as well as how to design the interaction of people with computers that disappear. The main conclusions from the wide ranging discussions held at the workshop can be summarized as follows.

Interaction Design: As computers disappear from the scene, become invisible and disappear from the perception of the users, a new set of issues is emerging concerning the interaction with computers embedded in everyday objects (smart artefacts): How can people interact with "invisible" devices? How can we design implicit interaction for sensor-based interfaces? How can we design for transparency and coherent experiences? Returning to the real world as the starting point for design and trying to exploit the affordances of real world objects seems to be one way of tackling these problems. Therefore, a major approach in this domain is to combine the best of real and virtual worlds resulting in hybrid worlds.

Sensing and Context: How can we sense and capture the "world around us", the parameters of our external physical and internal (eg, body) environments that inform and guide human behaviour? What are the relevant parameters to be used by systems supporting us? Location is certainly central but it is one parameter of a larger set determining the overall context. If context is key, what constitutes context and how can it be captured, processed and exploited for providing the services appropriate in a given situation? How do we arrive at context-aware systems? Does the collection of every facet of the sensed world, storage of every bit of information, and predicting the behaviour of users point in the right direction? Are the underlying mental models of interaction and perception sufficient? There are still major gaps towards solutions for real-world situations, not only in terms of scale but also in terms of open questions re decisions such as: How much should the system (or the infrastructure) remember? When does the system (or the infrastructure) try to predict the user's intentions and when are the users presented with choices?

Essential Infrastructure: Any infrastructure deployed to support ambient and ubiquitous computing will by definition have to be long lived and robust. Consequently new approaches to the evolution of the infrastructure, in situ upgrade and update, will be required. Given the potentially vast collection of devices, sensors and personalised applications, this update problem is significantly more complex than previously encountered. Additionally, since the infrastructure is meant to be invisible it will be necessary to develop an understanding of what failure means and how malfunctioning is communicated to the users. Consequently, new approaches to developing robust systems and applications will be required; ones that are fault tolerant, highly available, and that degrade gracefully.

Discovery: One of the key requirements to the provision of any disappeared computing infrastructure is an approach or service capable of assimilating and filtering information from various sources and determining relevance. This is essential for allowing users and applications to discover the necessary information from the environment to achieve a defined goal or complete an activity.

Programming Approaches: Models, languages, and support tools need to be radically redesigned to address the problem. Several issues were highlighted. In particular, the joint development of sensors, devices, applications and resources by designers, programmers and end-users, the programming in the face of uncertainty and partial knowledge, etc.

Privacy, Trust, and Security: The vast amounts of personal information collected by ubiquitous systems has led to growing concerns about the security, privacy, and trustworthiness of such systems and the data they hold. Moreover, it was identified that these observations are not merely an amplification of the current concerns of Internet

users with desktop computers. New approaches are required that take even more into account the underlying social and technical aspects that will, in the end, determine the acceptance of this technology by the general public.

Conclusions

The workshop showed progress towards the goal of the disappearing computer and a calm technology that serves people in an unobtrusive way. Despite the time that has passed since the early visions and implementations about 15 years ago, it is still a long way from achieving the complete vision. We have islands of results providing dedicated services and serving specific applications. They provide a test bed for the approaches that have been proposed and constitute milestones on our way towards a people-centred information and knowledge society.

Links:
The workshop report can be downloaded from: http://www.ercim.org/EU-NSF/.

A more elaborate presentation of work in this area can be found in the special section on 'The Disappearing Computer' in the March 2005 issue of Communications of the ACM (CACM) that was based on the discussions in this workshop.

Workshop website:
http://www.smartlab.cis.strath.ac.uk/EC-NSF/

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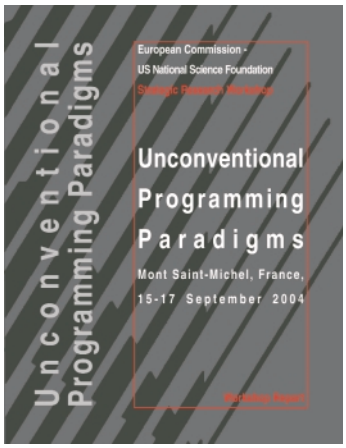

Unconventional Programming Paradigms

Programming paradigms or their concrete instantiations in programming languages are inspired either by the peculiarities of a computer or by a metaphor of what a computation should be. Considering the history of programming languages, metaphors that are working well today are mainly based on artefacts or on the notions and concepts that structure a domain of abstract activities (office, mathematics). In general however, various functional, object-oriented and logical programming methods developed in the 80s and 90s have not proved good enough to deal with modularity, reliability, re-usability, and maintainability, expressiveness, evolution, encapsulation, portability and ease of programming. In addition, the proliferation of existing software (and hardware) environments, the ever increasing user demands and the need for sharing information, skills and services stemming from the generalisation of data bases & communication networks generate additional difficulties to the traditional design of programmes. Programmes need now to be seen in an open & evolving framework, making it possible to dynamically incorporate services not initially foreseen. The new programming paradigm calls for new data & control structures, new programming strategies & computing models and evolving algorithms.

To cope with the above problems, as well as with needs from specific application areas, a number of new proposals based on 'natural metaphors' have been proposed. Examples include membrane and cell computing, artificial chemistry, declarative flow programming, bio-inspired computing systems such as L- and P-systems, amorphous computing, visual programming systems, musical programming, multi-media interaction, etc.

Overall, these new programming paradigms provide new abstractions and notations or propose new ways of interacting with programmes (ie visual programming, non linear programme representations, etc). They are implemented by embedding new data structures in a classical programming model, by extending an existing programming language with new constructs (for handling concurrency and exceptions and for evolving in open environments), by conceiving new software life cycles and programme execution (eg aspect-oriented programming, run time compilation) or by using entirely new computing metaphors. The practical applications of these new programming paradigms drive research investigations to address also the expressivity, semantics and implementation of programming languages and systems architectures, as well as the algorithmic complexity and optimization of programs.

Such programming paradigms are increasingly seen today as a reservoir of alternative avenues for counteracting the programming crisis we are experiencing. A representative sample of latest approaches was presented and discussed at the EU/NSF workshop on 'Unconventional Programming Paradigms'. The workshop was held on 15-17 September 2004 in Mont St Michel, France, with the participation of approximately 40 researchers coming from all over the world. Participants exchanged views on progress made in programming languages, to foster fertilization between theory and practice, and to promote the dissemination and take-up of new programming paradigms.

The workshop was designed around five leading tracks: Bio-inspired Computing, Chemical Computing, Amorphous Computing, Autonomic Computing, and Generative Programming.

Link:
The detailed workshop report and all the presentations made can be downloaded from: http://www.ercim.org/EU-NSF/

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Track at WWW2005

W3C is providing content for the 14th International World Wide Web Conference — WWW2005, to be held on 10-14 May 2004, in Chiba, Japan.

With eight sessions in the W3C track, attendees can expect substantive reports on the variety of technologies that bring the Web to its full potential, as well as insights on future work. In addition, attendees will have an opportunity to ask questions to the W3C Team. Tim Berners-Lee is giving the opening keynote of the WWW2005 conference.

Links:
W3C Track'05: http://www.w3.org/2005/01/w3c-track05.html
WWW2005: http://www2005.org/

W3C Seminar on Multimodal Web Applications for Embedded Systems

W3C is developing standards that support multiple modes of interaction: aural, visual and tactile. The Web then becomes accessible by using voice or hands via a key pad, keyboard, mouse or stylus. One can also listen to spoken prompts and audio, and view information on graphical displays.

The multimodal Web transforms the way how people interact with applications:

- In your hand: portable access to multimedia communication, news and entertainment services
- In your car: integrated dashboard system offering hands free navigation and infotainment services
- In your home: remote control of your everyday appliances, including television, video recorder, fridge, etc.
- In your office: choose how you interact with your computer, using a pen, keyboard or spoken commands.

W3C wishes to bring Web technologies to new environments such as mobile devices, automotive telematics and ambient intelligence. Already, many innovative multimodal Web applications have been developed, some of which will be showcased at the W3C seminar on multimodal Web applications for embedded systems, in Toulouse, 21 June 2005.

This seminar is funded by the Multimodal Web Interaction (MWeb) project, financed by the European Commission's FP6 IST Programme (unit INFSO-E1: Interfaces). Attendance to the seminar is free and open to the public.

Link:
Toulouse MWeb seminar page:
http://www.w3.org/2005/03/MWeb-seminar.html

Three W3C Workshops in early 2005: Rules Languages, Frameworks for Semantics

W3C Workshop on Rule Languages for Interoperability, Washington, D.C., USA, 27-28 April 2005

Rule languages and rule systems are widely used in applications ranging from database integration, service provisioning, and business process management to loan underwriting, privacy policies and Web services composition. General purpose rule languages remain relatively non standardized, however, and rule systems from different suppliers are rarely interoperable. More recently, RDF and OWL semantic Web languages are beginning to support data/knowledge sharing on the same scale and with considerable flexibility. Many consider that the next fundamental piece of the Semantic Web architecture is a standardized language for sharing rules.

Link:
http://www.w3.org/2004/12/rules-ws/cfp

W3C Workshop on Frameworks for Semantics in Web Services, Innsbruck, Austria, 9-10 June 2005

Web Services standards make up an integrated technology stack that Web applications developers can rely on to ensure interoperability. The initial emphasis of W3C's work has been on well-defined messaging interfaces and protocols, and registries in which services can be advertised. In addition, from the beginning, research has been conducted towards a broad range of challenges in this area, such as managing service lifecycles and resources; providing richer characterizations of processes, capabilities, and constraints; and composing a service from several other services. This workshop aims at gathering experience on applications and architectures that provide semantics for Web services, and at discussing various approaches for integration into the mainstream of Web services technologies, as well as the strategy and sequencing that could be put in place to accomplish this goal. This workshop is organized as part of the Web Services and Semantics (WS2) project, funded by the European Commission's IST FP6 Programme.

Link:
http://www.w3.org/2005/01/ws-swsf-cfp.html

W3C Workshop on XML Schema 1.0 User Experiences, June 21-22, 2005 - Redwood Shores, CA, USA

XML Schema 1.0 has been widely adopted by vendors and as a foundation for other specifications in the Web Services area, in XML query systems, and elsewhere.This workshop will gather concrete reports of user experience with XML Schema 1.0, and examine the full range of usability, implementation, and interoperability problems around the specification and its test suite. Topics of discusson include, but are not limited to, the use of XML Schema in vocabulary design, Web Services description and toolkits, XHTML, XML Query, and XML Schema editors.

Link:
http://www.w3.org/2005/03/xml-schema-user-cfp

W3C Standards Critical to Mobile Web Access

This year again, W3C staffed a booth to present W3C's mobile Web efforts at last 3GSM Congress from 14 to 17 February 2005, in Cannes, France.

Exploring the Web from a mobile device today has yet to fulfill its promise, due to obstacles in interoperability and usability. People often find that their favorite Web sites are difficult to access with a mobile device, if available at all. W3C's goal is to make Web access from a mobile device as simple, easy and convenient as it is from a desktop device. Supporters of the mobile Web recognize the tremendous business opportunity created by combining mobile and Web technologies. Key mobile services players such as authoring tool vendors, content providers, handset manufacturers, browser vendors and mobile phone operators share the same goal of enabling mobile devices to quickly become the first-class citizens of the Web.

Following the tremendous success of the Mobile Web Initiative workshop held two months ago, W3C expects to launch a Mobile Web Initiative in 2005 to focus on increasing the adoption of standardized technologies and identifying best practices for industry.

Link:
W3C@3GSM'05:http://www.w3.org/2005/02/3GSM-2005.html

W3C Devises Three-Part Solution for Better Web Services Performance

Web Services applications have the primary goal of sharing and using data between applications. This includes an increasingly diverse set of media formats and devices, including large schematics and other graphical files.

One of the biggest technical and performance issues for Web services occurs when a user or application is handling large binary files. Encoding binary data as XML produces huge files, which absorbs bandwidth and measurably slows down applications. For some devices, it slows down so much that the performance is considered unacceptable.

By enabling a more efficient way of serialize and transmit a SOAP message (XOP and MTOM), and by sending all the data needed to process the message, even when the data would not be readily available (RRSHB), Web Services have just become faster and more usable. These three newest published W3C Recommendations work with SOAP 1.2.

Links:
XOP: http://www.w3.org/TR/2005/REC-xop10-20050125/
MTOM: http://www.w3.org/TR/2005/REC-soap12-mtom-20050125/
RRSHB: http://www.w3.org/TR/2005/REC-soap12-rep-20050125/
W3C Web Services Activity: http://www.w3.org/2002/ws/

W3C Issued Critical Internationalization Recommendation

The goal of the Character Model for the World Wide Web is to facilitate use of the Web by all people, regardless of their language, script, writing system, and cultural conventions, in accordance with the W3C goal of universal access. One basic prerequisite to achieve this goal is to be able to transmit and process the characters used around the world in a well-defined and well-understood way.

As the number of Web applications increases, the need for a shared character model has become more critical. Unicode is the natural choice as the basis for that shared model, especially as applications developers begin to consolidate their encoding options. However, applying Unicode to the Web requires additional specifications; this is the purpose of the W3C Character Model series.

'Character Model of the World Wide Web - Fundamentals' is the first in a set of three documents. Building on the Universal Character Set defined by Unicode and ISO/IEC 10646, it gives authors of specifications, software developers, and content developers a common reference for text manipulation. The two other specifications are in development: "Character Model for the World Wide Web 1.0: Normalization" specifies early uniform normalization and string identity matching for text manipulation, and 'Character Model for the World Wide Web 1.0: Resource Identifiers' specifyies IRI (International Resource Identifier) conventions.

Links:
Character Model of the World Wide Web Fundamentals:
http://www.w3.org/TR/2005/REC-charmod-20050215/
W3C Internationalization (I18N) Activity:
http://www.w3.org/International/

Latest W3C Recommendations

- SOAP Message Transmission Optimization Mechanism
  25 January 2005, Hervé Ruellan, Noah Mendelsohn, Mark Nottingham, Martin Gudgin
- Resource Representation SOAP Header Block
  25 January 2005, Martin Gudgin, Anish Karmarkar, Yves Lafon
- XML-binary Optimized Packaging
  25 January 2005, Mark Nottingham, Noah Mendelsohn, Hervé Ruellan, Martin Gudgin
- XML Inclusions (XInclude) Version 1.0
  20 December 2004, Jonathan Marsh, David Orchard

An exhaustive list of all W3C Technical Reports:
http://www.w3.org/TR/

Environmental Modelling

by Thomas Lux and Achim Sydow

The topic of environmental modelling was last addressed in Issue 34 of ERCIM News, in July 1998. Influenced by the Kyoto Protocol (adopted on 11 December 1997), public awareness of environmental problems had at that time reached a peak. The goal of this thematic issue is to look at the pervasion of modern information and communication technology into the environmental and ecological sciences.

The power of today's computational and communication resources means that we are able to create modelling, simulation and decision-support tools with unprecedented quality. Modelling the biosphere with ever-greater numbers of biotic and abiotic components remains a great challenge of our time. Climate research (space weather included) uses models dealing with varying scales and resolutions, and will require new architectures with access to distributed resources. Branch-oriented simulation systems should prove the right software tools to be flexibly adapted to the special structure and data of complex environmental systems.

Environmental applications carry with them a number of special demands. These include complexity (dimension, structure with abiotic and biotic subsystems), scale (amount of data, distribution, heterogeneity), modelling for different purposes (scenario analysis, emergency response, risk management etc), the need for adaptability (coupling of models, parameter adjustment etc), longevity of data and applicability to different purposes.

These demands have led to a variety of current research themes, such as parallel, distributed and Grid computing, knowledge from data, decision support, intelligent/adaptive user interfaces and visualization, standardization of metadata and system interfaces, workflows for automatic access to distributed resources, and the generic nature of information and simulation systems.

The ERCIM Working Group Environmental Modelling (http://wwwold.first.fhg.de/applications/em.html) provides a platform for the discussion of research in this area and invites interested groups to join.

History and Milestones

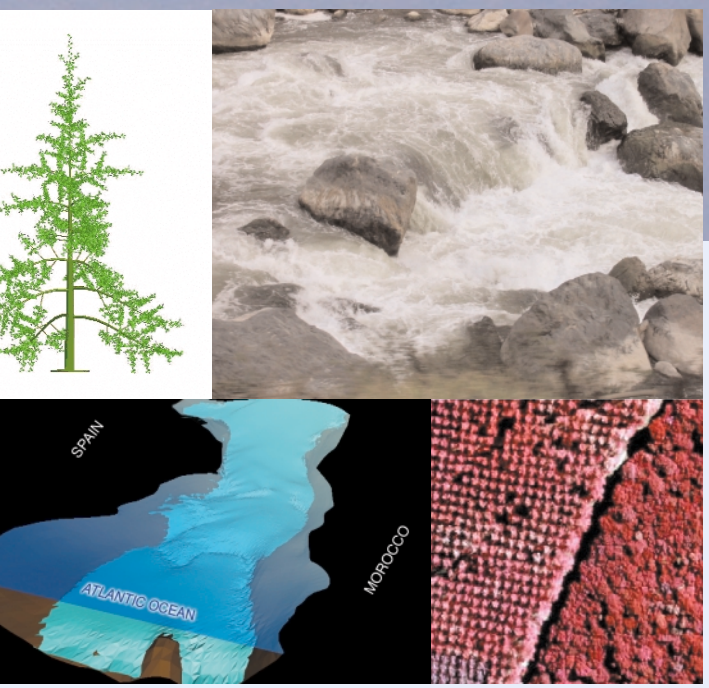
While environmental modelling based on physics has a long tradition, modelling biotic components is a relatively new challenge. All these models have only become really useful, however, in connection with computer applications. Mathematical models and simulation software (including numerical analysis) are therefore strongly dependent on each other. It is interesting to note that simulation is both the tool and the research aim in environmental engineering. Without simulation there would be few discoveries in this field, for example, chaotic processes! This dependency is illustrated by two examples from the history of environmental modelling.

Example 1: Atmospheric Processes

On 1 July 1946, J. von Neumann (1903-1957) began to look at meteorology: his aim was to develop a numerical weather prediction model. He simplified the basic meteorological equations such that only meteorologically relevant solutions were produced, and the numerical methods were stable. Two years later the meteorologist Jule Charney (1917-1981) joined the team and also dealt with this question.

The complete equations, with meteorologically insignificant higher frequent oscillations, had been considered thirty years earlier by L. F. Richardson (weather prediction by numerical processes, 1922) in the model area with ‘staggered grids’. However, Richardson estimated that solving these would have required the efforts of 64,000 technicians. At one point, von Neumann was in a position to use for a month the army’s computer, ENIAC (Electronic Integrator and Calculator), in order to solve the simplified model. He created basic methods for programming algorithms including sub-programs, iteration blocks and recursive blocks, all of which are now ubiquitous in software technology. Von Neumann considered the problem of modelling atmospheric processes to be one of the most complicated problems possible, after the analysis of human behaviour in conflict situations.

Today a hierarchy of models exists for studying the space-time spectrum of phenomena like long waves, fronts, hurricanes, thunderstorms, tornados, micro-turbulences etc. In connection with projects of the ERCIM Working Group on Environmental Modelling, ozone models and remote data sensing via satellites have also been included. Since the time of those pioneers of numerical simulation, one task that remains is model instabilities.



Example 2: Growth Processes / Population Dynamics

Growth processes are the basis of ecological modelling. In 1961, the meteorologist E. L. Lorenz used greatly simplified weather forecast equations to show that tiny errors in initial conditions could make forecasts outside of a certain time period impossible (deterministic chaos). This chaotic behaviour was also found in models of basic growth processes. For example, the equation developed by Verhulst in 1845 (the discrete version of which is today known as logistic growth, or growth with limited food), also produces chaotic behaviour. An interesting offshoot from this discovery is the development of wonderful two-dimensional computer art.

It is often desirable in ecology to analyse distributed growth processes structured in food chains (A. J. Lotka, 1888-1949, E. P. Odum, 1983). Lotka and Volterra developed their famous predator-prey model along these lines. Models including only three species could display chaotic behaviour, depending on the non-linearities of the coupled species.

The basic tools include models for logistic growth, delayed logistic growth (M. Smith 1968), exponential growth etc. Depending on the ecosystems to be analysed, transport, diffusion and other processes must be modelled.

An enormous problem is determining the initial conditions for model runs, in the case of weather forecasting, climate research, ecosystems research etc. Extensive data assimilation via different methods, including remote sensing by satellite measuring is needed. A great challenge for environmental modelling!

ARTICLES IN THIS SECTION

Introduction

e-Collaboration and Grid-on-Demand Computing for Earth Science at ESA

by Luigi Fusco, Veronica Guidetti and Joost van Bemmelen

Information and Communication Technologies (ICT) have proven to be key instruments in activities targeted at protecting the environment and its integration in sustainable development policies. The European Space Agency (ESA) considers GRID computing capabilities as powerful tools to manage large volumes of Earth observation data and provide the Earth Science community with on-demand services. ESA is currently involved in several projects requiring a Grid infrastructure to support e-collaboration and digital library applications.

One of the key requirements faced by the earth and environmental science community is to improve collaboration across the many geographically-distributed research groups and enable them to share data acquired by diverse means (ground, airborne and satellite), computational and storage resources, knowledge, experimental results.

Complexity is caused by the fact that:
- very often a single instrument can serve several applications and a given application might need to access all available instruments;
- each application needs specific time and space data sampling;
- standards and data handling practises differ in different research communities.

The Grid and emerging e-collaboration computing services are considered as powerful new instruments, enabling and strengthening remote collaboration among researchers. For example, a Grid-based infrastructure can permit alternative approaches to access and exploit large data sets. Instead of traditional remote sensing data ordering and delivery from the acquisition/storage facilities to the user sites, user specialised processing modules could be located wherever data and computing resources are available. Specific on-demand data products, based on the best user-defined parameters, could then be generated or retrieved from archives and downloaded in real-time. Such services can be available via the web to members of a virtual thematic community, using the emerging Web Services standards.

The European Space Agency at the ESRIN site (Frascati, Italy) has the mandate to acquire, process, archive and distribute data coming from the Earth observation satellites operated in Europe, organised in a fully distributed network of facilities all over Europe. The ESA historical archive already includes some 2 PetaBytes of data and the flagship ENVISAT mission, launched in 2002, is increasing this data holding by some 400 TeraBytes per year.

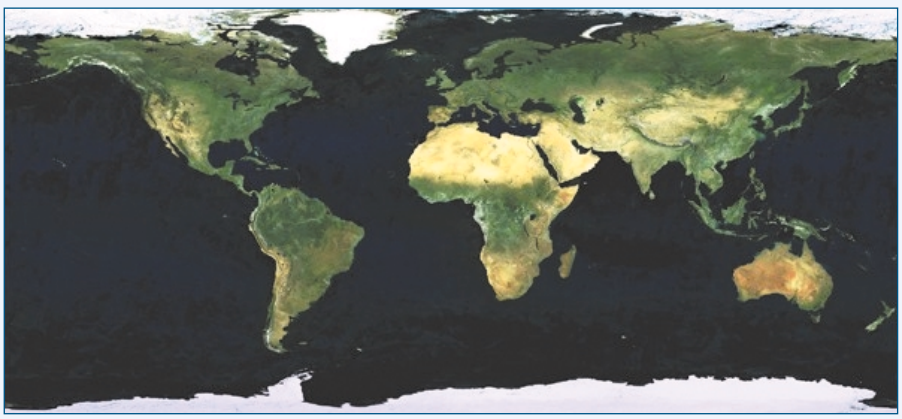


Figure 1: MERIS mosaic image using data from the months of May, July, October and November 2004. This image is made up of true colour images using four out of 15 MERIS spectral bands taken from Envisat (bands 2,3,5 and 7) with data combined from the selected separate orbital segments with the intention of minimizing cloud cover as much as possible by using the corresponding data flags. In total, more than 1 TeraByte of data was processed to generate a final image of about 1 GigaByte.

In recent years, ESA-ESRIN has experimented with the Grid and is currently involved in several applications and projects ranging from e-collaboration to the organisation of information in ad-hoc digital libraries, organised around the established Grid infrastructure. ESA intends to adopt the Grid computing philosophy for handling the instrument data of future Earth observation missions.

Grid-on-Demand Specific Applications

Following successful demonstrations of GRID applications for Earth Science, both in studies funded by the ESA General Study Programme (ESA-GSP) and through participation in EC-funded projects, n 2004 a schedule to define new GRID-based applications at ESRIN was planned to render mature GRID-based applications operational. In particular, the integration of the ENVISAT MERIS dedicated data processing tool (BEAM) in the so-called 'Grid on-Demand' activity was completed. Through Grid-on-Demand, authorised users can generate level-3 products (ie uniformly time and space remapped geophysical variables) used, for example, for the monthly mosaicking of the global chlorophyll or vegetation status derived from MERIS instrument data (see Figure 1).

Grid on-Demand supports scientific applications for future large ENVISAT

data set access. Together with the high-performance processing capability of the Grid, it provides quick accessibility to data, computing resources and results. Figure 2 shows support for a science group interested in new algorithm development and fast validation of results.

The power of the Grid infrastructure will help to process and manage large amounts of satellite images, thus forming the basis for long term data preservation, while digital library common functionality and third party applications will allow the users to retrieve, analyze and manage the contents, the services and the virtual organisation.

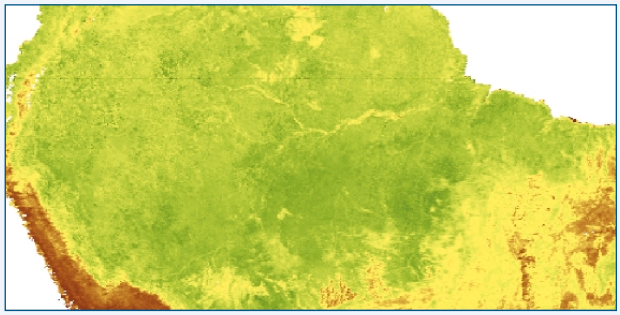


Figure 2: MGVI (MERIS Global Vegetation Index) Time composite (May 2004) algorithm for FAPAR product developed by JRC (Nadine Gabron, A Time Composite Algorithm for FAPAR products Theoretical Basis Document JRC Publication No. EUR 20150 EN).

e-Collaboration

ESA also sees the Grid as a powerful means to improve the integration of data and measurements coming from very different sources to form a Collaborative Environment. The ESA-GSP project 'THE VOICE' (THEmatic Vertical Organisations and Implementation of Collaborative Environments, see http://www.esa-thevoice.org) aims at building an infrastructure that allows collaboration between different groups of researchers in the Earth observation field and generates scientific prototypes in the domain of ozone data calibration and validation, in the establishment of GMES (Global Monitoring for Environment and Security) application innovative partnerships, in the agriculture and forest rural areas monitoring and the marine applications communities.

Concluding Remarks

As already happened with the World Wide Web, the Grid together with e-Collaboration technology is expected to have a deep impact on our life, not necessarily restricted to scientific applications. However, the extent to which Grid technology will be exploited in the future is closely connected to the adoption of common standards to allow different grids to collaborate, ie to work together.

For the Earth science community, it is important to continue and invest in activities focussing on Grid and e-collaboration. Initiatives such as ESA Grid-on-demand and projects like THE VOICE are demonstrating their relevance. These projects show that a Grid-based underlying infrastructure is a real asset for this community. It significantly improves the accessibility and usability of Earth science data, information and knowledge, and the way Earth science users collaborate.

Links:
Grid-on-Demand: http://eogrid.esrin.esa.int
THE VOICE: http://www.esa-thevoice.org

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ERAMAS — Environmental Risk Analysis and Management System

by Thilo Ernst, Andreas Hoheisel, Thomas Lux and Steffen Unger

The aim of the ERAMAS project is to develop a Grid-based system for analysing and managing pollutant-related environmental risks. Sophisticated simulation programs are used to forecast and evaluate the dispersion of carcinogenic and chemically toxic substances in the atmosphere, the soil and the groundwater, and to calculate the risk they pose to humans.

ERAMAS is a simulation-based analysis framework for calculating risks due to chemically toxic or carcinogenic substances being released, for example during accidents in industrial installations, the transport of dangerous goods or by terrorist attacks. It is designed to be applicable both for real-time emergency management and for risk mitigation activities such as simulation-aided studies concerning the design of approval procedures or emergency plans.

Figure 1 shows an overview of the simulation models involved in ERAMAS regarding various transportation paths for pollutants in the atmosphere and the soil. In the environmental simulation domain, this is a typical scenario; nevertheless, integrating and coupling even a small number of heterogeneous simulation models, and making them available to technically unskilled users, amounts to a very complex and time-consuming effort.

ERAMAS is being developed using the technology of the Fraunhofer Resource Grid (http://www.fhrg.fraunhofer.de), which simplifies the coupling of heterogeneously distributed software, hard-

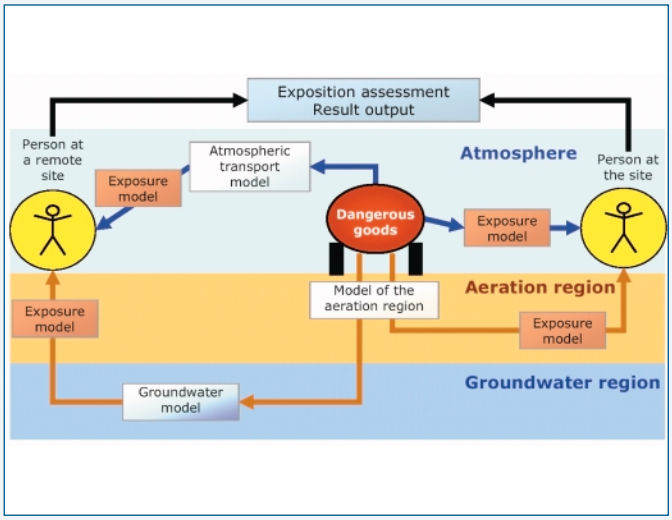

Figure 1: Simulation models of ERAMAS.

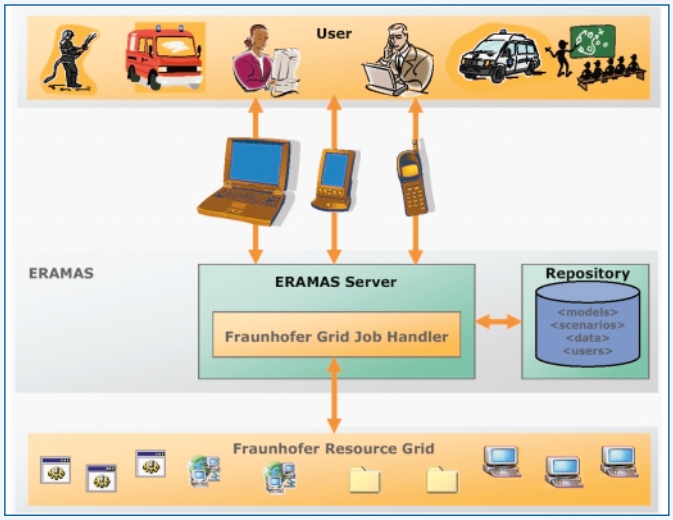

Figure 2: System architecture of ERAMAS.

ware and data resources (see Figure 2). The Fraunhofer Resource Grid is a Grid initiative comprising five Fraunhofer institutes and funded by the German Federal Ministry of Education and Research. Its main objectives are to develop and implement a stable and robust Grid infrastructure within the Fraunhofer Gesellschaft, to integrate available resources, and to provide internal and external users with a user-friendly interface for controlling distributed applications and services on the Grid.

ERAMAS is a system with considerable resource demands. These arise not only from the inner complexity of its components, but also from complex workflows and usage scenarios in which a substantial number of component instances need to be executed, eg parameter studies. Such a system cannot be expected to run on a single workstation; parallel and distributed computing techniques are obviously necessary. However, the primary advantage of using Grid technology in ERAMAS is not the performance gain from having access to additional resources, but rather the organizational advantages in building and maintaining a distributed, highly heterogeneous simulation system. The Grid is used to organize the workflow of coupled simulations and to provide uniform access to a wide variety of hardware, software and data resources. The component abstractions offered by the Fraunhofer Resource Grid make the coupling of a wide range of models and data sources very easy - detailed knowledge of the internals of the components is no longer needed.

The simulation components integrated in ERAMAS are pure command-line applications, that is, they have no graphical user interface. Specialized simulators usually originate from the research sector, where this is considered normal. However, it conflicts severely with the goals of and application scenarios envisioned for ERAMAS, which call for strong support of the less technically skilled user, such as users from on-site emergency response teams. This gap is bridged by relying on the VirtualLab platform (http://vl.nz.dlr.de/VL), which is being developed through collaboration between the German Aerospace Center (DLR) and Fraunhofer FIRST. VirtualLab contains a subsystem for dynamically generating flexible and easy-to-use Web user interfaces for command-line applications, using abstract descriptions of their input datasets. Together with its generic Web portal features (such as protected user areas that persistently store simulation runs, integrated documentation management, and Web-based administration), VirtualLab is thus able to provide a powerful Web access layer for ERAMAS.

The ERAMAS system is being developed by Fraunhofer FIRST, in collaboration with Ingenieurbüro Beger für Umweltanalyse und Forschung and the Dresdner Grundwasser Consulting GmbH in Germany. The project is funded by the Arbeitsgemeinschaft industrieller Forschungseinrichtungen Otto von Guericke (AiF) in the programme Innovationskompetenz mittelständischer Unternehmen (PRO INNO).

The funded ERAMAS project commenced in July 2002 and finished in October 2004, and the result is a demonstration prototype of the ERAMAS system. ERAMAS can be viewed as a pilot project that is introducing Grid- and Web-based e-science methods into the environmental simulation and risk management community, and is developing and deploying a dedicated platform for the purpose.

Our aim for the future is to make ERAMAS a commercially operated service that can be used in a variety of ways, eg for advance analysis in licensing procedures or for drawing up action plans. Potential customers include chemical companies, haulage contractors and emergency services like the fire service. Another application area is analysis under real-time conditions, whether in the case of malfunctions in industrial plants, the transport of hazardous materials or terrorist attacks.

Links:
http://www.first.fraunhofer.de/en/eramas
http://www.fhrg.fraunhofer.de
http://www.first.fraunhofer.de/en/vlab

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GENIE: Grid Enabled Integrated Earth System Model

by Andrew Price, Tim Lenton, Simon Cox, Paul Valdes, John Shepherd and the GENIE team

An understanding of the astonishing and, as yet, unexplained natural variability of past climate is an essential pre-requisite to increase confidence in predictions of long-term future climate change. GENIE is a new Grid-enabled modelling framework that can compose an extensive range of Earth System Models (ESMs) for simulation over multi-millennial timescales, to study ice age cycles and long-term human induced global change. Grid technology is a key enabler for the flexible coupling of constituent models, subsequent execution of the resulting ESMs and the management of the data that they generate.

To predict the future, we must understand the past. In the case of planet Earth we do not yet fully understand the mechanisms that have driven the most fundamental change in climate over the past million years – the transitions between ice ages and warm inter-glacials. To improve understanding of the physical processes and feedbacks that are important in the Earth System, the GENIE project is creating a component framework that allows the flexible coupling of constituent models (ocean, atmosphere, land, etc.) of varying resolution (grid sizes), dimensionality (2D and 3D models) and comprehensiveness (resolved physics vs. parameterisations) to form new integrated ESMs. Through the systematic study of a hierarchy of GENIE models the project aims to determine the spatial resolution and process complexity that actually need to be included in an ESM to exhibit past Earth System behaviour.

The GENIE project is funded by the National Environment Research Council (NERC) and brings together expertise from UK and international academic institutions. The Universities of Bristol and East Anglia, the Southampton Oceanography Centre and the Centre for Ecology and Hydrology have provided mature models of major Earth System components including atmosphere, ocean, sea ice, ocean biogeochemistry, sediments, land vegetation and soil, and ice sheets. The e-Science centres at the University of Southampton and Imperial College have been engaged to provide the software infrastructure for the composition, execution and management of the integrated Earth System Models and their output on the Grid. We have strong international collaborations with researchers at the Frontier Research Centre for Global Change in Japan, University of Bern in Switzerland and University of British Columbia in Vancouver.

e-Science Challenge

The objectives of the GENIE project are to develop a Grid-based computing framework which will allow us:

- to flexibly couple together state-of-the-art components to form a unified Earth System Model (ESM),
- to execute the resulting ESM across a computational Grid,
- to share the distributed data produced by simulation runs, and
- to provide high-level open access to the system, creating and supporting virtual organisations of Earth System modellers.

Software

Grid computing technology is required to ease the construction of new instances of Earth system model, automate the process of model tuning, speed up the execution of individual long integrations, enable large ensembles to be run, ease their execution, and feed and recycle data back into model development. A principle aim of the project is to ensure that the Grid is useable directly from the environment where the climate modellers are performing their work. The software deployed to meet these requirements is built upon products of the first phase of the UK e-Science programme. These include:

- Geodise Compute Toolbox
  The Geodise computational toolbox for Matlab provides a suite of Matlab functions that provide programmatic access to Globus Grid enabled compute resources. The computational toolbox uses the APIs provided by the Java CoG toolkit to allow the submission of compute jobs to Globus enabled resources, GridFTP data transfer and the management of proxy certificates. An interface to Condor resources is also provided.

- Geodise Database Toolbox
  An augmented version of the Geodise Database Toolbox has been deployed to provide a distributed data management solution for the GENIE project. The Geodise system exploits database technology to enable rich metadata to be associated with any data file, script or binary submitted to the repository for archiving. XML schemas define the structure of the metadata and are mapped into the underlying Oracle 9i database. The database system is built on open W3C compliant standards technologies and is accessed through a web services interface. Client tools are provided in Matlab and Jython which allow both programmatic and GUI access to the system.

- OptionsMatlab
  OPTIONS is a design exploration and optimisation package that has been developed in the Computational Engineering and Design Centre at the University of Southampton. This software provides a suite of sophisticated multidimensional optimisation algo-

rithms developed primarily for engineering design optimisation. The package has been made available to Matlab via the OptionsMatlab interface and has been exploited in conjunction with the Geodise Toolboxes to tune GENIE model parameters.

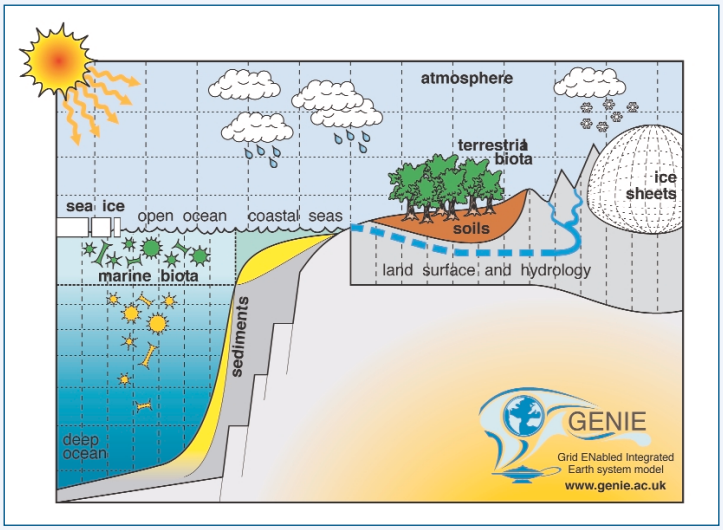
Tuning

A key challenge to the project is to tune or re-tune the parameterisations of individual model components so that the new coupled ESMs simulate reasonable climate states. In particular, it is imperative that the fluxes passed between components are compatible if the resulting coupled model is to be stable. We have exploited the Grid enabled toolset in conjunction with the OPTIONS package to apply Response Surface Modelling techniques and Genetic Algorithms to optimise GENIE model parameters. In addition, the ensemble Kalman Filter, a data assimilation method, has also been employed. These techniques provide a comprehensive set of tools for a program of extensive model tuning which has progressed in step with model development.

Current and Future Study

We are exploiting local resources (condor pools, Beowulf clusters) and the UK National Grid Service to perform extensive studies of GENIE models. The computational Grid provides the means to perform large ensemble runs. To date, experiments have studied the stability of the thermohaline circulation to multi-parameter freshwater inputs, using typically ~1000 instantiations of the model, involving ~40 million years of model integration.

The database repository plays a central role in these studies as a resource for both steering computation and sharing of the data. Future work will involve the development of a distributed federated database system, deployment of the database on the National Grid Service data node(s) and further enhancements to the data management tools. The project will adopt the GeodiseLab Toolbox from the OMII (Open Middleware Infrastructure Institute) managed programme when this product is released to the community.



Schematic of the Earth System components that are modelled in GENIE.

Links:
http://www.genie.ac.uk/
http://www.geodise.org/
http://www.omii.ac.uk/

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Chemistry GRID and its Applications for Air Pollution Forecasting

by Róbert Lovas, István Lagzi, László Kullmann and Ákos Bencsura

Computational Grid systems are becoming increasingly popular in the natural sciences. In such systems, a large number of heterogeneous computer resources are interconnected to solve complex problems. The main aim of the national research project funded by the Hungarian Ministry of Education, 'Chemistry Grid and its Applications for Air Pollution Forecasting', was to look at feasible applications of Grid technology in computational chemistry from a practical point of view; for example, prevention of the harmful effects of high-level ozone concentrations.

In the project, the consortium (SZTAKI; Chemical Research Institute of the Hungarian Academy of Sciences; Department of Physical Chemistry, Eötvös University; Hungarian Meteorological Service) applied new Grid technologies to provide support for a specific research area. The developed infrastructure now provides chemists with access to both Hungarian computational Grid resources, called HUNGRID, and European-wide chemistry Grid infrastructures. The latter were established as the result of the EU-funded projects SIMBEX and EGEE.

SZTAKI has elaborated a product line: a Grid-monitoring tool called Mercury, and two integrated application development environments, called P-GRADE parallel programming environment, and P-GRADE Grid portal (see Figure 2). These tools enable the efficient and transparent parallelization of sequential applications through their high-level graphical approach and special performance debugging and analyser tools. In the framework of the project, the P-GRADE portal was developed further to provide support for the efficient execution of complex programs in various Grids, eg in HUNGRID. It included the dynamic execution of applications across Grid resources according to the actual state and availability conditions provided by the new information system.

Consequently, HUNGRID is not only a virtual organization within the EGEE: its new elements make it easier to use the infrastructure for solving complex problems, such as the modelling of air pollution.

The phytotoxic nature of ozone was recognized decades ago. Due to high emissions of ozone precursor substances, elevated ozone concentrations may cover large areas of Europe for shorter (episodic) or longer periods under certain meteorological conditions. These elevated concentrations can be potentially damaging to agricultural and natural vegetation. Occasional extreme concentrations may cause visible injury to vegetation, while long-term exposure, averaged over the growing season, can result in decreased productivity and crop yield.

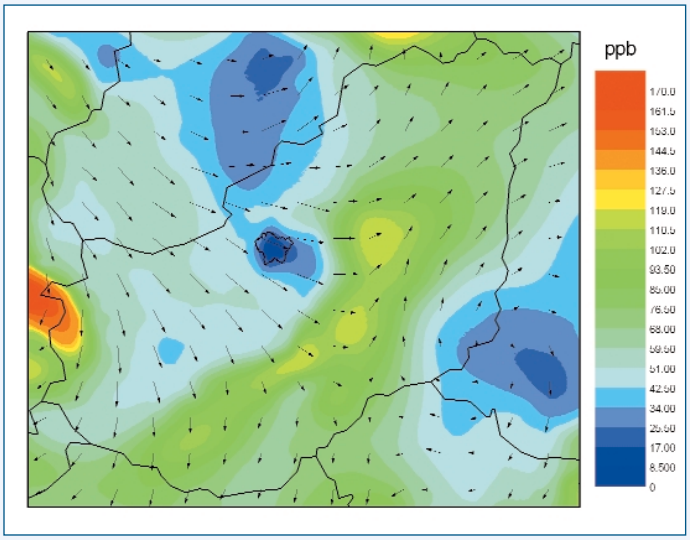

Figure 1: Calculated ozone concentrations on the 3rd of August, 1998 at 17:00, with the wind field taken from the ALADIN weather prediction model.

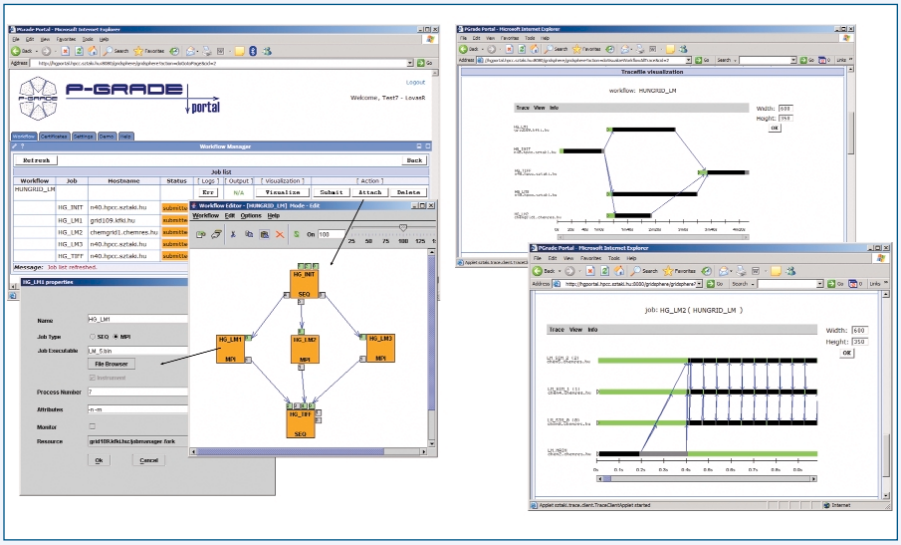

Figure 2: (left) An application for modelling reaction-diffusion-advection systems in the P-GRADE portal (workflow representation and job description); (right) workflow and job level monitoring and visualization of execution on the HUNGRID infrastructure.

A coupled Eulerian photochemical reaction–transport model and a detailed ozone dry-deposition model were developed to investigate ozone fluxes over Hungary. The reaction-diffusion-advection equations relating to air pollution formation, transport and deposition are solved on an unstructured triangular grid. The model domain covers Central Europe including Hungary, which is located at the centre of the domain and is covered by a high-resolution nested grid. The sophisticated dry-deposition model estimates the dry-deposition velocity of ozone by calculating the aerodynamics, the quasi-laminar boundary layer and the canopy resistance. The meteorological data utilized in the model were generated by the ALADIN meso-scale limited-area numerical weather prediction model, which is used by the Hungarian Meteorological Service. The work demonstrates that the spatial distribution of ozone concentrations is a less accurate measure of the effective ozone load than the spatial distribution of ozone fluxes. The fluxes obtained show characteristic spatial patterns, which depend on soil moisture, meteorological conditions, ozone concentrations and the underlying land use (see Figure 1).

This project has demonstrated that the Grid is an efficient computer system for supporting complex collaborative work. Applications for air pollution forecasting (elaboration of smog alert response plans and a Gaussian plume simulation) have been developed and presented. The project partners have designed a collaborative application that runs on Grid to forecast air pollution in Hungary. The same application can be used to simulate earlier smog events and to analyse the efficiency of smog alert response plans and the long-term effects of various measures against air pollution.

Link:
http://www.lpds.sztaki.hu/chemistrygrid

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MEDARD – An Environmental Modelling Project for the Territory of the Czech Republic

by Kryštof Eben, Pavel Jurus, Jaroslav Resler, Michal Belda and Bernd C. Krueger

With the progress of the computing power of Linux clusters, operational installations of numerical weather prediction (NWP) models and chemistry transport models (CTM) have begun to spread through academic institutions across Europe. One such project focusing on the territory of the Czech Republic is MEDARD – a Meteorological and Environmental Data Assimilating system for Regional Domains. The system is run by the Institute of Computer Science of the Czech Academy of Sciences, in Prague. Its core consists of the NWP model MM5 (PSU/NCAR) coupled with the CTM model CAMx (ENVIRON Corp, USA). Data assimilation routines are under development.

In the Czech Republic, an operational statistical predictor of summer photochemical smog situations has been used since 2000. This system uses a neural network predictor and a dynamic regression model. Its inputs are the daily maxima of tropospheric ozone concentrations and temperature, measured at the ground-level stations of the Automatic Immission Monitoring system (AIM) of the Czech Hydrometeorological institute. The resulting concentration field is obtained by means of spatial interpolation. Although this system reasonably predicts daily ozone concentration maxima, there is a need for a deterministic model which would give reliable values for regions sparsely covered by AIM stations and which would reflect the air circulation. On the other hand, deterministic models often suffer from uncertainties in emission inputs; systematic bias in some locations may occur. It is also desirable to make use of any available measurements. A system with incorporated data assimilation therefore represents a natural target for modelling efforts.

The primary aim of the MEDARD project is the development of such a system for air quality forecasting. Its origins date to 2001 when the first steps were made during the EU framework V project APPETISE. The project is currently supported by the grant agency of the Academy of Sciences of the Czech Republic, within the framework of the 'Information Society' programme (No 1ET400300414). It involves researchers from the Institute of Computer Science (ICS) of the Czech Academy of Sciences, in collaboration with Charles University, the Czech Hydrometeorological Institute and the Institute of Meteorology at the University of Natural Resources and Applied Life Sciences in Vienna.

A suitable NWP-CTM model pair was sought for this purpose. The most natural choice for the NWP model was MM5, which is widely used in both the USA and Europe (eg the EURAD group; http://www.eurad.uni-koeln.de). The model was configured for the territory of the Czech Republic. It has two nested domains with resolutions 27 and 9km. We run the NOAH land surface model (http://www.mmm.ucar.edu/mm5/lsm). The boundary conditions are taken from the GFS global forecast of National Centers for Environmental Prediction (NCEP, USA).

The CAMx model was chosen as the CTM part of the system. CAMx has pre-

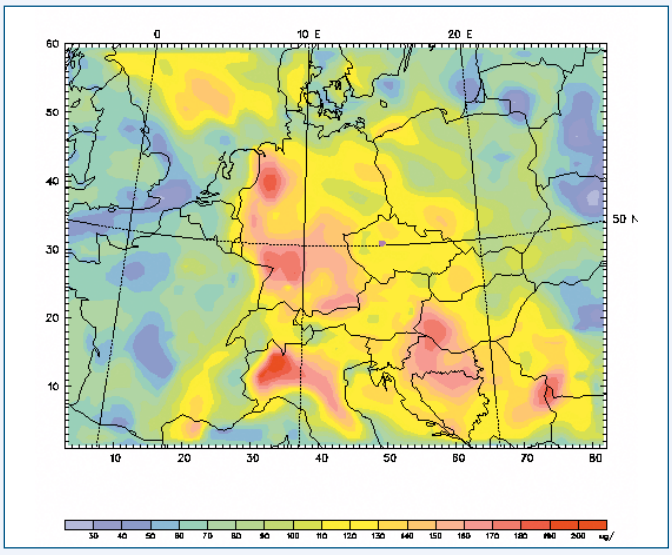

Figure 1: Ozone concentrations — assimilated.

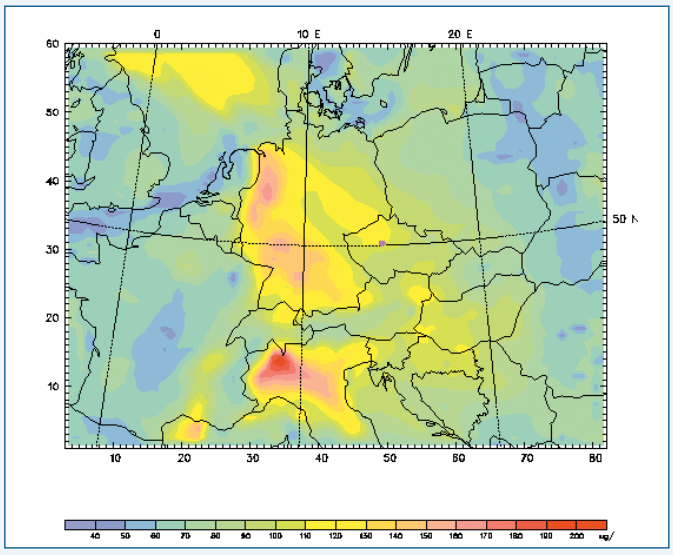

Figure 2: Ozone concentrations — free run.

processors for meteorological fields from MM5, and in our configuration it runs on two nested domains derived from the above MM5 domains. We use the Carter SAPRC99 chemistry mechanism (http://pah.cert.ucr.edu/~carter/SAPRC99.htm) and EMEP emission inventories (EMEP is a Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air pollutants in Europe, http://www.emep.int).

Upon the MM5-CAMx pair, a common presentation layer was built. The results are available at a user-friendly Web site intended for the general public. It was designed so as to provide a quick orientation to the situation, and features two alternative displays, animation and quick switching of domains and products. In the field of data assimilation, a type of ensemble filter suitable for the CAMx model has been proposed and is in the testing phase. Pilot experiments are being run, with the aim of determining how much data assimilation will improve operational forecasts. Figures 1 and 2 show an example of the output of an ensemble run: the ensemble mean of ozone concentration (Figure1) compared to the output of a free run without data assimilation (Figure 2).

Soon after the project commenced and the first weather prediction outputs became available, demand arose from the private sector for specialized outputs like lightning activity indices, risk of icing and local wind profiles. Some products of this kind have accordingly been developed. It also emerged that public interest is biased towards weather prediction, with interest in air quality being marginal. We are attempting to attract more interest in air quality issues by presenting the outputs of the CTM as a product of comparable importance to weather forecasts.

Commencing an operational run of the air quality forecast with incorporated data assimilation, however, requires a longer time schedule. Any such system will need on-line data, not only from the country immediately involved but also, due to transport phenomena, from neighbouring countries. Unfortunately there remain large differences between individual countries in the availability of on-line measurements of pollutant concentrations.

A big effort has to be made in designing a system for the downloading and validation of these on-line measurements. Together with the enormous computing-power demands of assimilation methods, the development of an operational data assimilating system for air quality prediction remains a significant challenge.

Link:
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OASI: Integrated Monitoring and Decision Support for Environmental Systems

by Roberto Mastropietro, Lorenzo Sommaruga and Andrea E. Rizzoli

OASI is a system for regularly and automatically collecting environmental data from a network of hundreds of sensors distributed throughout the Canton of Ticino in southern Switzerland. It has been in successful operation for several months.

Canton Ticino is the southernmost part of Switzerland and it lies right on one of the most important European transport axis, connecting Italy with Central Europe. It is a sub alpine region, with remarkable natural beauties, but its environment is subject to many pressures, among which road emissions play a major role. In 2001 the Swiss government decided to tackle the problem of the growing traffic on the main national highways by funding initiatives aimed at making available the necessary data and tools to understand the impact of traffic on the environment, in order to enable policy makers to make appropriate decisions.

Within this context, the Land Management Department of Canton Ticino launched a project to develop an integrated monitoring and decision support system to collect, analyse and process multi-domain environmental data. The project outcome has been named OASI (Osservatorio Ambientale Svizzera Italiana), and was developed by SUPSI/DTI, the Department of Innovative Technologies at the University of Applied Science of Southern Switzerland.

OASI regularly and automatically collects environmental data from a network of hundreds of sensors distributed all over Canton Ticino. Then, the collected data automatically undergo a statistical, intersite and interdomain validation process before being made available to the end-users. In this process, past data, already validated, are used to detect anomalies in the measurements which have been recently collected.

Scientists can access the data repository via the OASI application in order to perform integrated data analyses. Users can select locations, parameters, time intervals and diagram types. Multiple curves can be displayed and compared in a single diagram. Data belonging to different domains can be shown on a single screen, for comparison purposes, as shown in Figure 1.

The OASI software system has a scalable architecture that allows additional

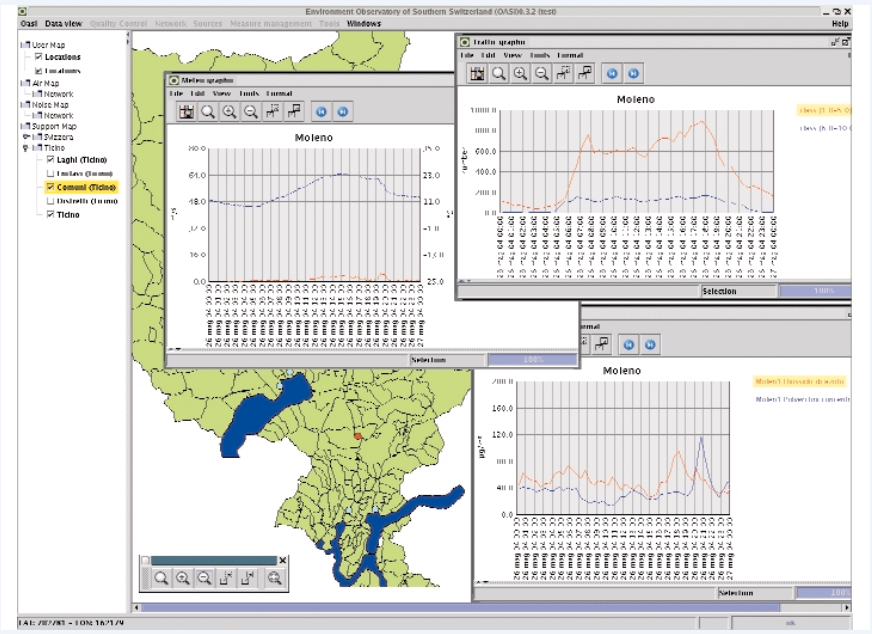

Figure 1: A screenshot of the OASI workspace.

data domains, as diverse as basin levels and landslides monitoring indicators, to be seamlessly added to the set of monitored data. This is achieved thanks to its 3-tier architecture composed of a data layer, a logical layer and a presentation layer — and to a flexible database design.

Data from different domains are collected in separate databases in the data layer, but they can be transparently integrated for validation and analysis in the logical layer. The software architecture therefore easily supports the integration of multiple databases, and it allows the deployment of the system in distributed configurations making the solution flexible and scalable. The system allows the definition of user roles and data ownership. An organization may or may not allow its data to be seen or modified by users belonging to other organizations

One of the most challenging aspects of the project is related to the amount of measurements being collected and the size of the databases, which results in interesting storage management and system performance issues solved using special design and advanced techniques made available by the database management system (Andretta et al. 2004).

Finally, the presentation layer is designed to serve both the needs of scientists and researchers as well the general public that wants to be informed on the state of the environment.

The OASI system has been running in production mode for a few months and it has raised the interest of other Cantons that are now also integrating their data in the system for validation and analysis purposes.

Further developments of the OASI project will push towards the provision of an even more open and mobile access to data, supporting interoperability among different client-server nodes, easy extensibility for integrating any kind of client device into the system, both for regular users and system administrators. In particular, within the OASI context, Web services technology will be effectively exploited for integrating the needs for dissemination of analytical data about environment, such as air, noise, traffic, etc., and the needs of different users having accessibility requirements for their devices, being distributed and heterogeneous systems, remote and mobile clients (Arauco and Sommaruga, 2004).

Link:
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Data Assimilation and Air Pollution Forecasting: the Berlin Case

by German Ariel Torres, Steffen Unger, Torsten Asselmeyer-Maluga, Vivien Mallet, Denis Quélo, Bruno Sportisse, Isabelle Herlin and Jean-Paul Berroir

In a joint French-German project, a three-dimensional chemistry-transport model called Polair3D has been improved in order to achieve better air pollution forecasts.

The first objective of this project was to prepare the Polair3D model for forecasting the air pollution in the Berlin-Brandenburg area. Polair3D is a 3D chemistry-transport model developed by Cerea (ENPC - EdF R&D), and is used for air quality forecasting at both continental (Europe) and regional scales (urban air pollution in Paris, Lille and Marseille). The second objective is to improve the quality of the forecasts by developing a sequential data assimilation

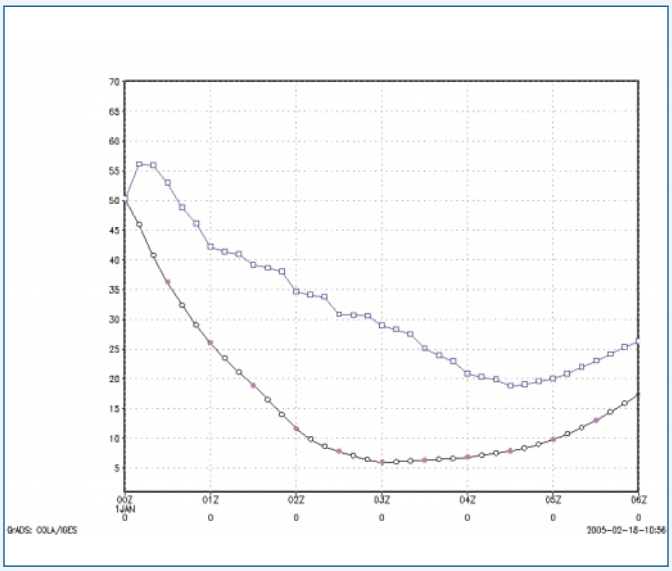

Figure 1: Impact of assimilation. The blue curve is a forward run showing the ozone concentration over a one-day period at a single location. The black curve is obtained after assimilation of the measurements (shown as purple dots).

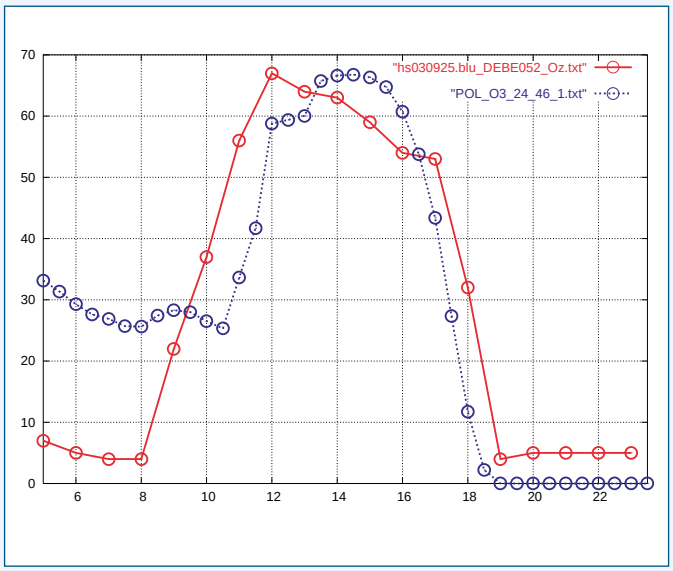

Figure 2: Forecast of ozone concentration with Polair3D model, during a one-day period (red curve), compared with ground station measurements at the same place (blue curve). The two curves show good agreement, except at the beginning of the day, because of an incorrect initialization.

framework adapted to Polair3D. Experiments are run by assimilating data provided by the Berlin air pollution monitoring network Blume.

Running Polair3D on a new application site requires a set of input data to be prepared. This comprises:

- the meteorological fields, generated by the mesoscale meteorological model MM5, which was developed by the Pennsylvania State University and the National Center for Atmospheric Research
- the emission inventory, based on EMEP European emission inventory and on the CityDelta project for urban emissions in the Berlin-Brandenburg area
- the boundary conditions, obtained by nesting Berlin regional runs within Polair3D runs at a European scale, now routinely performed.

The methodology is systematic, and can be applied to regional air pollution forecasting with Polair3D in any European city for which a CityDelta emission inventory is available.

Following this phase, sequential data assimilation is used to adjust model inputs and parameters, in order to minimize the difference between forecasts and measurements. This process is performed each time a new measurement is acquired, hence the name 'sequential'. Data assimilation therefore helps to improve the quality of air pollution forecasts provided by the model.

One of the main advantages of sequential data assimilation is that it does not require the availability of an adjoint model, and can be implemented as a post-processing toolbox that can be plugged into any model with little effort. However, it carries a considerable computational cost, since it requires several forward runs for each new measurement.

During the project, two types of Kalman data assimilation procedure were implemented: a rank-reduced Kalman filter, which reduces the dimension of the problem, and an ensemble Kalman filter, where statistics of model errors are generated by performing many forward runs of the model. These procedures have been validated in case studies, and their use for the Berlin case is under development, since it requires the parallelization of the Kalman filter. We are currently carrying out an evaluation of Polair3D results by performing a set of forecasts for the test period April-September 2001. Forecast error statistics are then computed by comparing the forecasts with measured in situ data. The project will be completed by quantifying the improvement brought by sequential data assimilation relative to forward runs without assimilation. A comparison with variational data assimilation methods is also possible.

This work has been carried out in the framework of a French-German project, funded under the Procope programme, and supported by an ERCIM post-doctoral fellowship. It involves the Clime team, a common INRIA and ENPC project located in the Paris area, and Fraunhofer FIRST, Berlin. Research was carried out at the three sites - INRIA, ENPC and Fraunhofer - during the period 2003-2004.

The project is continuing through cooperation with the University of Córdoba in Argentina. Polair3D will be used for air quality forecasts in this area, which will require the preparation of an emission inventory. Sequential data assimilation will be used to improve knowledge of the emissions. During this project, the feasibility of assimilating satellite measurements of chemical concentrations will be studied.

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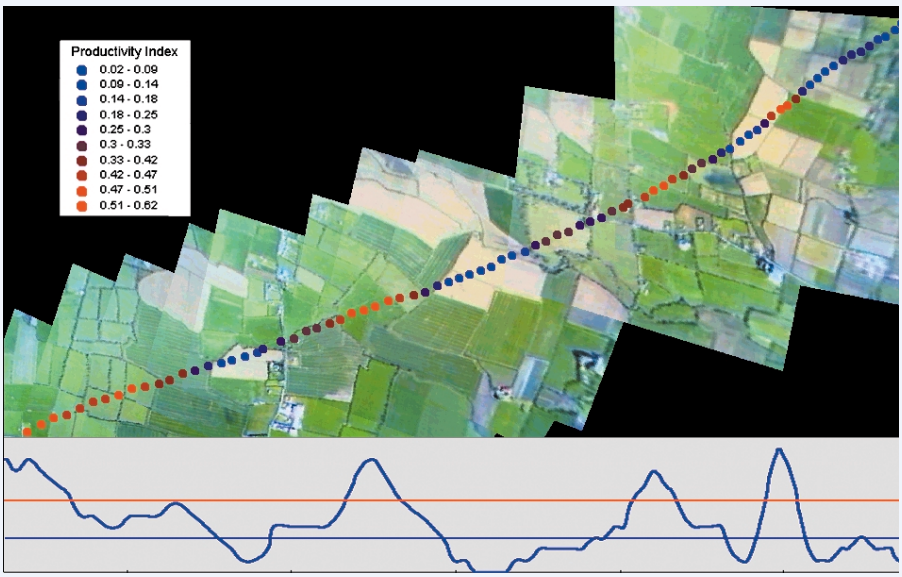
Extracting Maximum Information from Airborne Remote Sensing

by Eon O'Mongain and LiamTuohey

Computerized systems for environmental assessment and decision support depend fundamentally on measurements from which the maximum amount of information must be extracted. Research on the case of airborne remotely sensed data is discussed.

There is an increasing need for local and regional government authorities to acquire computerized systems to assist in evaluating the current status of the physical environment in their area and in assessing the impact of proposed future developments. In general such authorities already have extensive environmental sampling programs (eg water characteristics at designated places on streams, rivers and lakes; air quality at specific locations; noise levels along certain roads) whose outputs must be incorporated in the new systems. Also to be incorporated are such data as population densities, patterns of transport usage including car ownership, agricultural practices and patterns, industrial development and so on. The computerized systems must include relevant models of various aspects of the environment (eg associations between water quality and population density, agricultural production and phosphate/nitrate levels, traffic and air quality, local weather patterns, social capital and car usage), and must be capable of incorporating new data sources and models in the future. The utility of such systems depends crucially on the quality of their input data, which involves maximising the information yield from available measurements. The particular focus of this article is on extracting environmental information from airborne hyperspectral measurements.

Spectral Signatures is a University College Dublin campus company which for several years has specialised in extracting environmental information on water quality and land productivity by means of optical instruments that have been designed and built in-house. Capabilities include in-vivo and non-contact sampling of water Chlorophyll content, monitoring of Suspended matter and Dissolved Organic Matter and other pigments for the water industry, and remote sensing (airborne) application of hyperspectral techniques for water quality and land productivity quantification and mapping.



Vegetation (Productivity) Index and Video Images of a Land Area.

Pigments are chemical compounds that reflect only certain wavelengths of visible light, which makes them appear "colourful". More important is the ability of pigments to absorb certain wavelengths. In particular, Chlorophylls are greenish pigments of which the most important for photosynthesis is Chlorophyll a. In general, since each pigment reacts with only a narrow range of the spectrum, there is usually a need to produce several kinds of pigments, each of a different colour, to capture more of the sun's energy. Typically, each hyperspectral sample consists of 512 measurements, collected by means of an airborne 'Portable Multispectral Imaging Spectrometer', of the irradiance reflectance at equally spaced intervals in the visible spectrum. Flight campaigns have been carried out over several inland lakes and adjacents lands, with many samples collected during each flight.

Traditionally, broad band ratio techniques, which would make use of just a subset of the available measured reflectances, have been used to convert multispectral measurements into estimates or indices of vegetative biomass or photosynthetic activity. An important part of the present work is the development of full spectral vegetation indices, with the aim of extracting the maximum amount of information from measurements. The figure provides an example of such an index, overlaid on simultaneously taken video images.

In general, absorption data contain chemical information while scattering data contain information on physical characteristics of particles. An important

objective of the present research is to establish a systematic approach to extracting, from observations, maximum information on the ratio of scattering to total attenuation (scattering + absorption) in order to characterize lakes (and in-shore waters) comprehensively. The approach is to develop accurate mathematical models of the radiative transfer process, starting from classical solutions but drawing on modern tools such as Mathematica to make them more tractable (see, for example, Picard style iteration for anisotropic H-functions, W.G. Tuohey, Journal of Quantitative Spectroscopy and Radiative Transfer, In press January 2005).

In conclusion, the aim is to establish an accurate, reliable, easily updateable, and relatively inexpensive source of information on the environmental quality of water bodies and on the productivity of their catchment areas. This source would constitute a key underlying component of a computerized environmental evaluation system as described at the outset. In particular, a decision support system might include integration of this information source with in-situ measurements of environmental quality within or near waste water systems or discharges.

Link:
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Getting the Most out of Earth Observation

by Martin Juckes

The imperative to understand our environment becomes ever more urgent as global change brings new uncertainties. At the same time, rapid technological advances are making it possible to observe the global environment from space in ever finer detail. In response to the challenges of handling an ever greater volume and diversity of data, the Multiple Instrument Stratospheric Tracer Assimilation (MISTA) project at Rutherford Appleton Laboratory has developed a new algorithm for extracting optimal information from satellite measurements. Thanks to gains in efficiency, a task normally done on supercomputers, can now be carried out easily on a PC.

Photons leaving the Earth's atmosphere carry the signature of the emitting gasses. Space instruments orbiting the Earth use a variety of filtering and detecting technologies to measure these photons and thence provide information which can be used to determine the state and composition of the atmosphere.

Imaging devices on geostationary satellites, measuring visible light reflected from clouds or solid surfaces, can give global coverage every 15 minutes or so. But this luxury is not available for those who want to study atmospheric composition in detail.

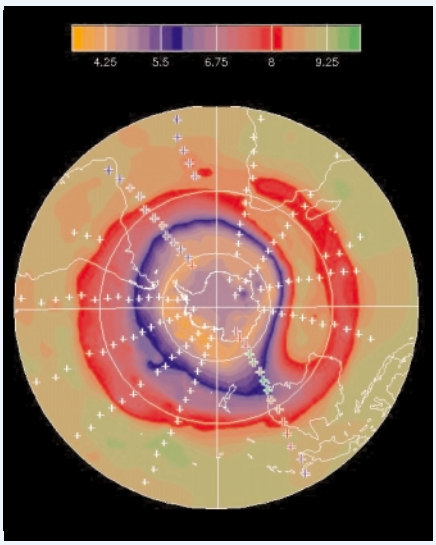
Our climate is significantly modulated by ozone, water vapour and methane in the stratosphere, all of which are present in concentrations of only 1 to 10 parts per million (10^6) by volume. Detection of the weak signal emitted by these gases requires satellites flying much closer to the Earth. Europe's environmental monitoring research satellite, ENVISAT, launched in 2003 at a cost of one billion Euro, is typical of this class of satellites, flying at around 800km altitude and orbiting the Earth every 100 minutes. The MISTA project has so far focused on results from one instrument on ENVISAT: the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS). Of the three instruments on ENVISAT which were designed to detect stratospheric gases MIPAS has been the most successful to date.

The greater detail which can be obtained by instruments flying closer to the Earth is gained at the expense of losing the regular global coverage provided by the geostationary instruments. MIPAS provides a string of observations along the satellite orbital path. As the Earth rotates under the orbit a picture of the global atmosphere can be built up. However, many of the features which are observed evolve significantly over the course of a day because of physical processes, many of which are well understood.

A wide range of methods have been developed to combine the prior knowledge we have of the physical processes with the information stream coming from the measurements. The problem can be formulated in a Bayesian framework, combining observational information with prior information expressed in a computational approximation to the relevant physical laws. So far so simple, at least to those involved in this area of research. The novelty in this project is in the way it tackles the numerical challenges thrown up by the Bayesian framework. Many other research institutes working on the same problem are exploiting existing forecast models. These are computational representations of the physical laws designed to predict the future state of the system from a prescribed initial state. The MISTA project has started from scratch and developed code specifically designed for

data analysis. This allows the full exploitation of the elliptical structure of the problem, a structure which follows naturally from a standard Bayesian formulation. A multigrid relaxation algorithm has been implemented. This type of algorithm is commonly used for the solution of elliptical partial differential equations, but has not been applied in this context before.

A particular advantage of the new algorithm is that it fully exploits observations both prior to and after an analysis time. Information propagates both forwards and backwards in time within the analysis system, with a typical half-life of around 2 days. This means that images such as the figure, which shows the ozone distribution in the stratosphere (at around 30km altitude) on July 6th, 2003, can be significantly more accurate than anything produced by a forecast system which, by its nature, can only exploit observations prior to the analysis.



Ozone concentration at 30km altitude (parts per billion by volume), 6 July 2003.

Link:
http://home.badc.rl.ac.uk/mjuckes/mista/

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Meso-Meteorological Modelling for Air Pollution Applications in Mid-Latitudes

by Jose-Luis Palau, Gorka Pérez-Landa and Millán M. Millán

Any approach to meteorological modelling needs to take into account a variety of processes that interact synergistically at different scales (mainly in mid-latitude and complex terrain areas). Because of their potential to resolve regional and local atmospheric circulations, meso-meteorological models represent interesting tools. They are highly complex and their adaptation to a particular region requires an in-depth understanding of the limits of parameterization applicability.

Over the past few years there has been a growing need to simulate meteorological fields for complex situations at finer spatial resolutions. This has been partly stimulated by scientific and technological advances (eg in dynamics, computational methods and facilities) and partly by policy pressures requiring more detailed assessments of air pollution on urban to regional scales. As a consequence, complex dynamic models have increasingly been used in Europe and the USA for meteorological and air pollution applications. Models developed for short- or long-range applications, however, are not always appropriate in flow conditions involving intermediate mesoscale features and processes (of the order of 1-1000 km). This is because parameterizations, working hypotheses and configurations need to be different for differently scaled models (as stated in the explanatory memorandum for the implementation of the European Concerted Research Action designated COST Action 728: 'Enhancing mesoscale meteorological modelling capabilities for air pollution and dispersion applications').

In this context, our group is interested in situations of complex atmospheric flows for which mesoscale models are necessary (eg sea breezes, valleys and layered flows). It is generally acknowledged that current models are far from perfect; our goal is therefore to identify the gaps in our knowledge. We are performing this research within the following European frameworks: the Cluster of European Air Quality Research (CLEAR) project FUMAPEX (integrated systems for Forecasting Urban Meteorology, Air pollution and Population EXposure); the Network of Excellence ACCENT ('Atmospheric Composition Change: A European Network'); and the 'CarboEurope-IP, Assessment of the European Terrestrial Carbon Balance'.

Meteorological fields applied to air quality models (from global to local scales) may contain significant uncertainties that adversely affect simulations. There are a large number of meteorological variables needed for 'generic' air quality models, including horizontal and vertical wind components, temperature, water vapour mixing ratio, cloud fraction and liquid-water content, precipitation (rain/snow), solar actinic flux, sea-level pressure, boundary layer depth, turbulence intensity, and surface fluxes for heat, moisture and momentum. In addition to these variables, the forecasting of air quality in mid-latitudes (as in Mediterranean coastal regions) is also highly sensitive to the fact that non-local (mesoscale) effects strongly determine flows at urban scales (as reiterative experimental results have evidenced).

The aforementioned atmospheric state variables are insufficient under meteorological conditions marked by non-local dynamic effects (as, for example, the compensatory subsidences over the Mediterranean coasts associated with the orographic injections resulting from the coupling of sea breezes and inland orographic upslope winds). In this sense, the meteorological models must be configured in such a way that they are able to reproduce the mesoscale dynamics at these subtropical latitudes. For instance, the interaction between different scales must be reproduced: land-use, soil moisture, sea-surface temperature, grid nesting, domain configuration, and horizontal and vertical resolution are key magnitudes/parameters in describing wind flows for air-pollution forecasting purposes and must be set up properly (see Figure 1).

In recent years, different research projects around the world have demonstrated that the pollutant 'exchange rate' between different regions and under different meteorological (and climatic) conditions is driven by interactions and forcings between different meteorological scales reaching distances of thousands of kilometres (see Figure 2).

For a believable evaluation of the impact of anthropogenic emissions from urban to global scales, one must therefore implement within numerical models all these spatial and temporal interactions, together with feedback from climate, regional air quality and transport (at local, regional and global scales). Moreover, in order to address certain issues (eg how different meteorological scales contribute to the Long-Range Transport - LRT - of regional pollution), it is necessary to resolve some scientific questions related to these meteorological interactions. In this sense, there are indications that the formation and distribution of photo-oxidants in urban plumes, at regional or continental scales, in the boundary layer and in the free troposphere, are all linked together. There are a number of EC research projects relevant to this, including MECAPIP - Meso-meteorological cycles of air pollution in the Iberian Peninsula; RECAPMA - Regional cycles of air pollution in the west central Mediterranean area; and SECAP - South European cycles of air pollution.

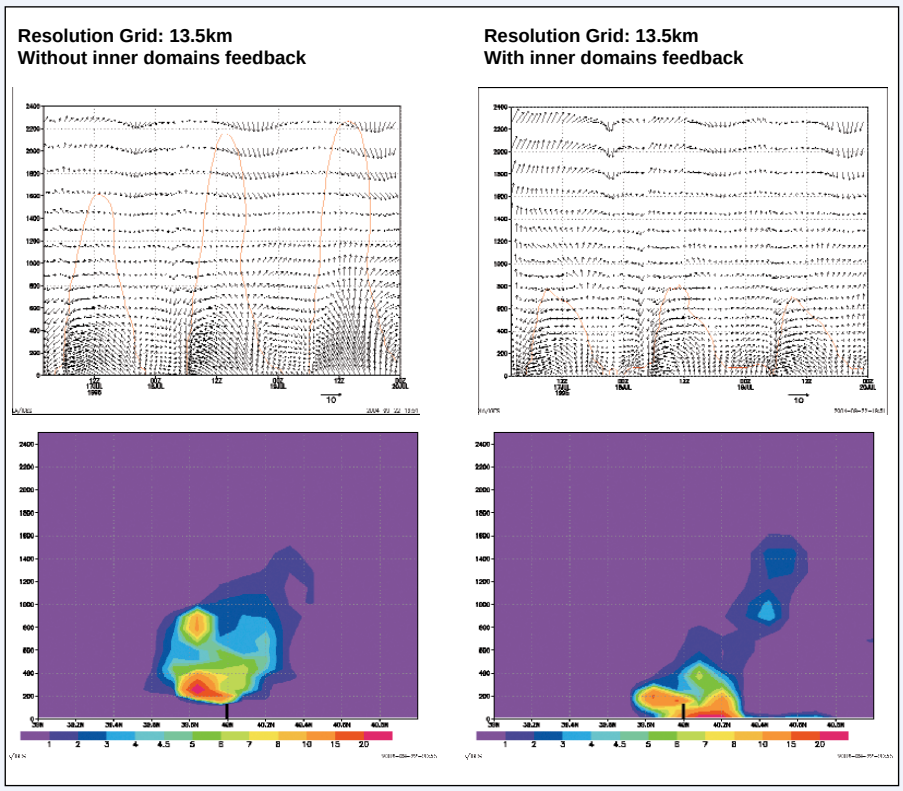

Figure 1: Meteorological (top) and dispersive (bottom) simulations performed by running RAMS v.4.3.0 and HYPACT v. 1.2.0 on a Mediterranean coastal site for three days in July.
Upper figures: Time evolution of the vertical distribution of the simulated wind fields and boundary layer height simulated on a Mediterranean coastal site using the same resolution grid. This analysis of the meteorological data shows important differences in the mesoscale model outputs between two different meteorological approaches. On the right, the high resolution effects are included thanks to the two-way option between grids (resolving 1.5km meteorological features) and on the left, the model uses the resolution of the grid (13.5 km) without any feedback from the inner domains.
Lower figures: To check the implications of the two different meteorological approaches in the simulation of a point-source plume in a Mediterranean coastal area, both model outputs were employed to run two respective Lagrangian dispersion simulations. As shown, the vertical distribution of the simulated SO_2 concentration emitted from a power plant (black vertical line) is strikingly different at identical simulated times. Units are g/m^3.

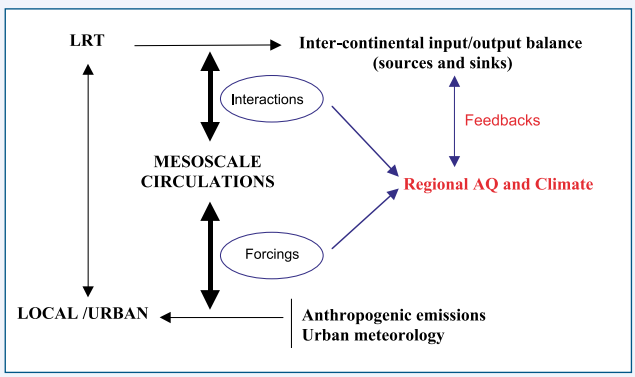

Figure 2: Feedbacks and interactions/forcings governing the transport of anthropogenic pollutants emitted at urban/local scales.

Experimental data and complementary modelling results from these projects have established links between atmospheric circulations from local, through regional, to sub-continental scales, particularly in summer and in the central and western Mediterranean basins.

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http://www.gva.es/ceam

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Air Pollution Modelling in Complex Terrain: 'Els Ports-Maestrat' Regional-Scale Study

by Jose-Luis Palau, Gorka Pérez-Landa and Millán M. Millán

Characterization of atmospheric pollutant dispersion (advection and turbulent diffusion) requires a detailed description of the wind and turbulence fields, especially on complex terrain under summer conditions. Gaussian regulatory models frequently incorporate simplifications that are not valid under these circumstances. Software-engineering development and technological advances within the hardware industry have permitted the use of high-performance computing systems that are able to supply the computing power necessary for high-resolution meteorological and Lagrangian simulations.

At present, the numerical simulation of atmospheric dynamics is a necessary tool for meteorological diagnosis, analysis and forecasting. At the beginning of the seventies, global models based on primitive equations represented an important development in the characterization of synoptic-scale atmospheric processes. Afterwards, the need to analyse lower-scale phenomena, together with the availability of increased computing power, resulted in the development of regional models (or limited-area models), which were capable of resolving mesoscale atmospheric features. In the Western Mediterranean Basin, characterized by strong mesoscale circulations, these regional models (executed with high-resolution meshes) are required to solve the atmospheric circulations/forcings.

During the last decade, the role of traditional supercomputers and workstations has been taken over by PCs. The huge PC market has benefited from the development of hardware technology and now shows an excellent price/performance ratio when compared with workstations. The growth of free software has facilitated the development of very productive software engineering capable of efficiently interconnecting computers and parallelizing the demands of computing power. Consequently, PC clusters are now able to respond to high-performance computing needs. This has been an important advance for most atmospheric research groups, giving them more computing power for mesoscale modelling purposes and at a lower cost.

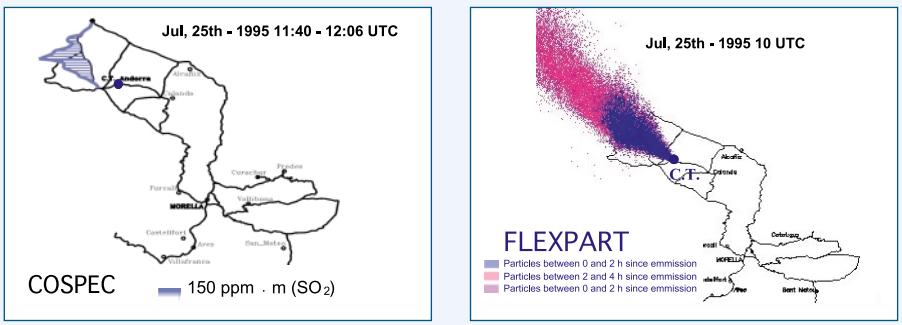

Figure 1: Experimental and modelled SO_2 plume, flowing NW from the power plant; (left) experimental measurements of the plume concentration distribution, obtained with the COSPEC over the road network around the power plant; (right) particle distribution simulated with the LPD, FLEXPART.

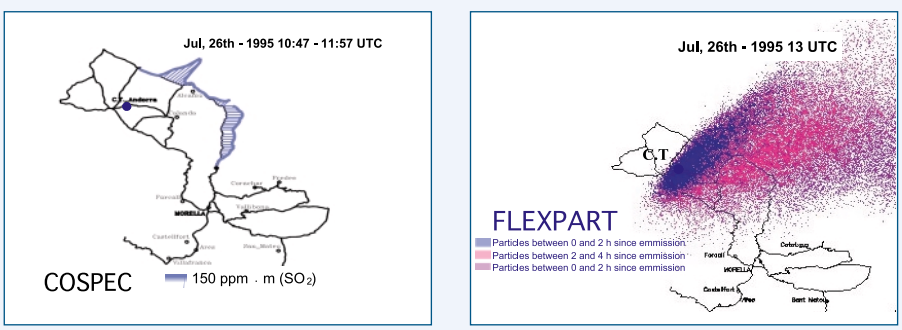

Figure 2: Experimental and modelled SO_2 plume, turning from the east towards the north (from the power plant); (left) experimental measurements of the plume concentration distribution, obtained with the COSPEC over the road network around the power plant; (right) particle distribution simulated with the LPD, FLEXPART.

One of our scientific objectives is to incorporate this new technology into the air pollution research being undertaken at our institution (at both national and international levels). One of our national research projects - the 'Els Ports-El Maestrat' project - is being used as a pilot case to fit these new technologies/methodologies to complex terrain areas with strong thermal and orographic forcings within the lower troposphere.

The 'Els Ports-El Maestrat' field campaigns are sponsored by the government of the Autonomous Community of Valencia, Spain (specifically the 'Conselleria de Territori i Habitatge' and the 'Conselleria de Cultura, Educació i Sport'), and have been conducted on the south-western border of the Ebro basin (Northeast Iberian Peninsula) since November 1994. One of the objectives of these field campaigns is to monitor (both aloft and on the ground) the plume of sulfur dioxide (SO_2) emitted from the 343m-tall chimney of the Andorra power plant located in Teruel (Spain). The 'Els

Ports' database consists of three independent (but related) meteorological and air-quality databases, along with a fourth database composed of two different types of forest plots: forest experimental sites dominated by conifers, and plots where lichen transplant experiments have been performed. Using these four databases, we aim to understand how different (meso and synoptic) meteorological processes determine pollutant dispersion within this Iberian Peninsula basin. In addition to this, we are able to use the new technology to describe the atmospheric dispersion of SO_2 emissions in summer from a power plant situated on very complex terrain in the Iberian Peninsula.

Through experimentation and modelling, the studies performed within this project attempt to characterize both the advection (through the reconstruction of three-dimensional wind fields) and the turbulent dispersion present during the period of analysis. Systematic SO_2 plume tracking was carried out for three days in July, by means of a vehicle equipped with a COSPEC (COrrelation SPECtrometer). This passive remote sensor utilizes solar radiation to obtain measurements of SO_2 distribution, both aloft and around the emission focus. In addition, the study used a non-hydrostatic mesoscale meteorological model, MM5, coupled to a Lagrangian Particle Dispersion (LPD) Model, FLEXPART. Simulated dispersion results are generally checked against measurements of tracer-pollutant surface concentrations, with the dispersion analysis limited to the impact areas. The availability of measurements aloft enables us to verify the patterns of advection and turbulent diffusion that govern air pollution dynamics in the area. This is followed by an analysis of the cause-effect relation between the emission source and the ground-level concentration.

The mesoscale model uses a nested-grid configuration with five domains (100x100 grids spaced at 108, 36, 12, 4 and 1.3 km, respectively) centred over the power plant. The model predicts the wind field and turbulence parameters. The LPD model solves the turbulent wind components via the Markov process, which takes into account wind velocity variances and the three Langrangian autocorrelations. To solve the inhomogeneous turbulence in this complex terrain, the time step used is considered to be a function of the Langrangian time scale.

From the point of view of advection (whole-body advection + differential advection), the coupled models were able to reproduce the typical stationary-dispersion scenarios as experimentally characterized with the COSPEC. However, a significant temporal delay was detected between the simulation and experimental measurements of the plume dispersion (see Figures 1 and 2).

From the point of view of turbulent dispersion (differential advection + turbulent diffusion), there is a significant discrepancy during the transition between dispersion scenarios (see Figure 2), between the experimental and modelled values of the horizontal distribution of plume concentration (sy, defined from the transversal axis to the average transport direction). This stands in contrast to the situation during stationary periods (see Figure 1). In the former situation, with no defined transport direction, classical dispersion parameters lose their physical meaning.

In conclusion, using an adequate configuration of these two models (MM5 and FLEXPART) and with the methodology shown, it is possible to simulate/characterize the main meso-meteorological and dispersive features in complex terrain under very strong insolation conditions (where Gaussian regulatory models fail when applied to air pollution sources).

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2-Days Ahead PM_{10} Prediction in Milan with Lazy Learning

by Giorgio Corani and Stefano Barazzetta

The lazy learning algorithm is used to predict PM_{10} air pollution levels in Milan, providing forecasts for the next two days with reasonable accuracy. In addition to the traditional data acquired by the air quality monitoring network, specific micrometeorological variables are algorithmically estimated and then used as input for our model.

Particulate matter (PM) is a mixture of particles that can adversely effect human health, damage materials and form atmospheric haze that degrades visibility. PM is usually divided up into different classes based on size, ranging from total suspended matter (TSP) to PM_{10} (particles less than 10 microns in aerodynamic diameter) to $PM_{2.5}$ (particles less than 2.5 microns). In general, the smallest particles pose the highest human health risks. PM exposure can affect breathing, aggravate existing respiratory and cardiovascular disease, alter the body's defense systems against foreign materials, and damage lung tissue, contributing to cancer and premature death. Particulate matter includes dust, dirt, soot, smoke and liquid droplets directly emitted into the air by sources such as factories, power plants, cars,

Cross-validation year	1999	2000	2001	2002	2003	Average
True/predicted correlation	0.747	0.688	0.672	0.717	0.576	0.680
Mean abs. Error [$\mu g/m^3$]	12.83	13.84	14.13	13.10	16.15	14.01
Mean error [$\mu g/m^3$]	0.59	0.45	0.29	0.20	-0.28	0.25
Prob. detection over-threshold values [%]	75.0%	70.3%	70.2%	65.0%	66.1%	69.32%
False alarm rate [%]	27.5%	31.1%	32.4%	34.5%	34.5%	32.00%

Table 1: Cross validation performances of the base model.

Cross-validation year	1999	2000	2001	2002	2003	Average
True/predicted correlation	0.804	0.748	0.679	0.752	0.642	0.725
Mean abs. Error [$\mu g/m^3$]	11.58	12.69	14.21	12.31	15.27	13.21
Mean error [$\mu g/m^3$]	0.804	0.748	0.679	0.752	0.642	-0.20
Prob. detection over-threshold values[%]	73.26%	79.80%	70.59%	68.97%	64.91%	71.50%
False alarm rate [%]	22.22%	25.47%	31.43%	29.20%	33.33%	28.33%

Table 2: Cross validation performances of the model enriched with micrometeorological indicators.

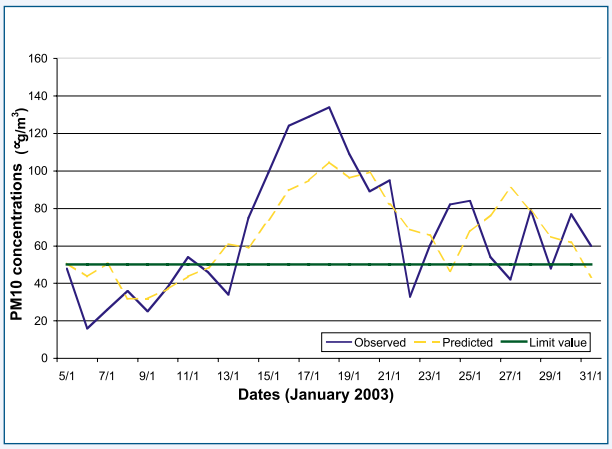

Figure 1: A simulation sample for January 2003.

construction activity, fires and natural windblown dust.

The 'Air Sentinel' project, developed by the 'Agenzia Milanese per la Mobilità e l'Ambiente' (Agency for Mobility and the Environment, Milan, Italy), aims at publishing forecasts of pollutant concentrations in Milan. One-day statistical linear predictors for different measuring stations of PM_{10} have already been shown to provide satisfactory performances. These models compute a prediction of the daily PM_{10} average for the current day at 9 a.m.. Evaluation of these predictors via cross-validation on a yearly scale shows a true/predicted correlation higher than 0.85, and a mean absolute error of about 10mg/m^3 (out of a yearly PM_{10} average of about 43mg/m3).

We have now developed a two-day predictor; ie, at 9 a.m. this model predicts the daily PM_{10} average for the following day. We use the lazy learning (LL) prediction approach by Bontempi et al. LL has been shown to be viable for nonlinear time series prediction and, in particular, also for air pollution prediction. The strengths of the lazy learning approach are its predictive accuracy, its fast design (the development of a LL model is much quicker than a neural network), the easy model update procedure, and the readability of the model structure. The most relevant contribution to LL development and diffusion in recent years has been probably done by the Machine Learning group working at the University of Bruxelles, which continuously produces LL algorithmic enhancements and applications, and also releases the LL implementation as open-source code.

The yearly average of PM_{10} in Milan is substantially stable (about 45 mg/m^3) since the beginning of monitoring in 1998 and, just to give an idea of the severity of the phenomenon, the PM_{10} daily average exceeds the limit (50mg/m3) about 100 times every year. PM_{10} concentrations in Milan follow a typical weekly and yearly pattern: in particular, winter concentrations are about as twice as high as summer ones, both because of unfavourable dispersion conditions and of the additional emissions due to residential heating. Sunday concentrations are about 25% lower than the other days of the week, because of the reduction in traffic volumes.

Our PM_{10} prediction application requires a careful investigation of the suitability of several variables; in addition to the traditional data available from the air quality network (such as pollutant concentrations, wind speed and direction, temperature, atmospheric pressure etc., measured at the ground level), we also consider micrometeorological variables (such as mixing layer height, Monin-Obukhov length, etc.). These variables are algorithmically estimated and make it possible to characterize the dispersion conditions.

Results and Discussion

We present the results obtained by cross-validating the model. At each run, a year of data is used as the testing set in order to assess the ability of the model to predict previously unseen data. We compare the performances of the base model (whose inputs are PM_{10} (ie, autoregressive term), SO2, temperature and atmospheric pressure), with those of the model with micrometeorological data. The probability of detecting over-threshold values and the false alarm rate refer to a threshold value set at 50mg/m3.

Provided that predictions of the model are available as a range of values, rather than as a crisp number, the forecast accuracy can be considered satisfactory, especially if micrometeorological data are used. Figure 1 provides a simulation sample for January 2003.

Links:

Website of the Machine Learning group at the University of Bruxelles: http://www.ulb.ac.be/di/mlg/

Repository of papers presented at the 9th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes (Garmish, 2004), including the paper by Barazzetta and Corani dealing with 1-day ahead prediction of PM_{10} : http://www.harmo.org/conferences/Proceedings/_Garmisch/Garmisch_proceedings.asp

Chapter dedicated to the air quality within the State of the Environment Report of Milan (published by Agenzia Mobilità e Ambiente): http://81.208.25.93/RSA/capitolo_3/main_capitolo.htm

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Better Weather Forecasts with Use of Conservation Laws

by Jason Frank

Research at CWI aims to ensure structure in the midst of chaos. In long-time simulations of weather and climate, the Hamiltonian Particle Mesh method preserves Hamiltonian structure, and thereby energy, mass and vorticity. This technique could provide better quality solutions for weather forecasts.

Chaos was identified in meteorological systems in the 1960s by E.N. Lorenz. All solution curves of Lorenz's equations eventually become confined to a bounded region of space, yet two different solutions with only slightly perturbed initial conditions diverge from one another at an exponential rate. This divergence has dire consequences for any attempt to simulate the weather or climate with a computer, since errors that are necessarily made in the process of representing the original, analytical model in discrete form may be seen as perturbations of the solution. These unavoidable errors will, under the influence of chaos, cause the simulated solution to diverge from the true solution exponentially. With current numerical weather prediction technology, model and observation errors overwhelm the solution in roughly ten days.

On the other hand, the errors incurred in a numerical computer simulation are not random but systematic, taking the form of phase errors, numerical damping and so forth. For well-designed methods, the simulated solution may, while diverging exponentially from the true trajectory, still remain close to or 'shadow' some other solution satisfying a modified initial state, modified parameters, or even a perturbed model. In such cases, the solution may still be meaningful when properly interpreted. In other words, one may still be accurately simulating some weather; it is just unlikely that it will be the actual observed weather.

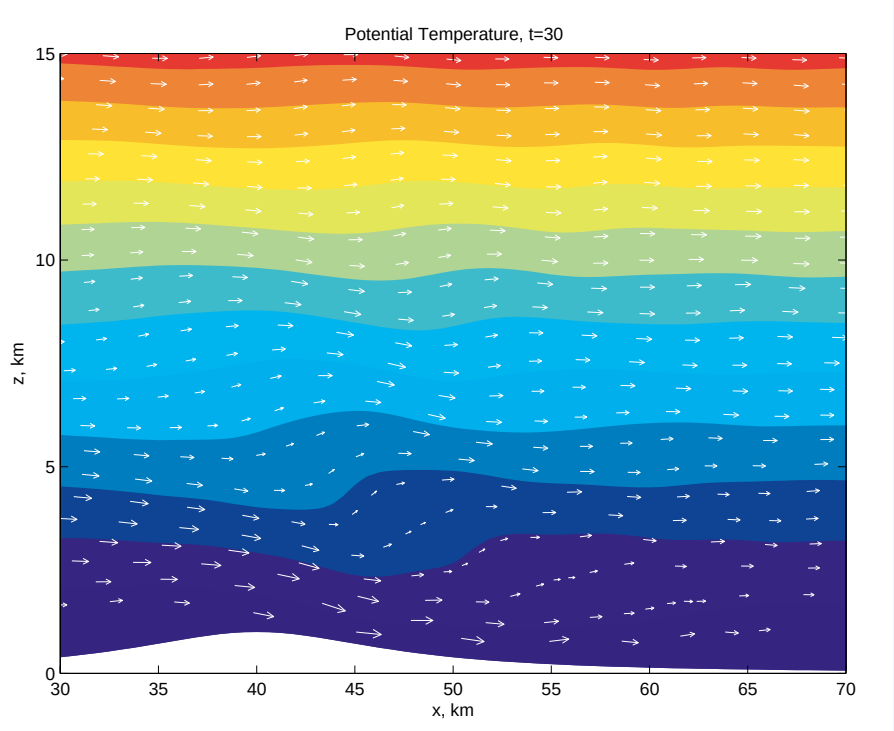

Figure 1: Simulation of a 2D non-hydrostatic flow over a mountain ridge, computed using the HPM method. (Source: CWI.)

To deal with chaos, modern predictions of weather and climate often utilize an ensemble of simulations: a whole series of runs in each of which the initial state of the system is slightly perturbed. This yields a distribution of weather scenarios that can be subjected to statistical methods, and allows one to make statements like: "In 73% of all trials, rain was predicted for Amsterdam next Thursday".

When carrying out simulations on long-time intervals in which the numerical map is iterated, say, a hundred thousand to a hundred million times, the qualitative differences between algorithms become amplified. It is therefore crucial to employ methods having properties similar to those of the physical model being simulated (such as energy and mass conservation) or having similar mathematical structure (such as symmetries).

Research at CWI, in collaboration with Potsdam University, focuses on preservation of Hamiltonian structure in simulations of atmospheric models. Hamiltonian structure lies at the root of classical mechanical systems, and can be used to unveil many of the conservation laws present in such systems. Since viscosity can be neglected in large-scale atmospheric flows, the equations of motion are conservative, and from the Hamiltonian structure one can derive conservation laws of mass, energy and vorticity. By ensuring that the computational algorithm also adheres to this structure we can automatically guarantee that these conservation laws will also be inherited by the simulated solution. The preservation of Hamiltonian structure also has important implications for ensemble simulations. One can think of an ensemble of initial conditions as a set

of points in space, each tracing out a solution. Initially the points are close together: for example, they form a ball. The ball is stretched and deformed as each point follows its solution trajectory. However, for Hamiltonian systems, the volume of the ball remains constant. This property is also inherited by the numerical method, and ensures that the members of an ensemble of simulations will each explore different possible scenarios, as opposed to being contracted to a smaller number of extremal solutions.

Preserving Hamiltonian structure using standard, purely grid-based computational techniques is difficult if not impossible. Instead we follow an approach in which a fluid is represented by a finite number of particles representing fluid masses, which satisfy classical mechanical equations of motion. For computational expediency, the potential field in which the particles move is represented on a grid. This is all carefully formulated to preserve Hamiltonian structure. The result is the Hamiltonian Particle-Mesh (HPM) method.

The HPM method has been under development since 2001. It has been used successfully for rotating planar and spherical shallow water equations, two-layer flows, and most recently, 2D vertical non-hydrostatic flow over topography. Figure 1 shows a simulation of a 2D non-hydrostatic flow over a mountain ridge using the HPM method, with the wind field (arrows) and potential temperature (color contours) indicated. Interest in non-hydrostatic models has grown in recent years as increased computational power has allowed higher grid resolutions to be attained. Current plans in this project address the issues surrounding 3D simulations.

Links:
http://www.cwi.nl/projects/gi/HPM/
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Modelling Ecological Health using AI Techniques

by Martin Paysley and Bill Walley

The conservation of the natural environment is crucial to our long term survival. Scientists are now turning to artificial intelligence as a basis for better understanding of our surroundings.

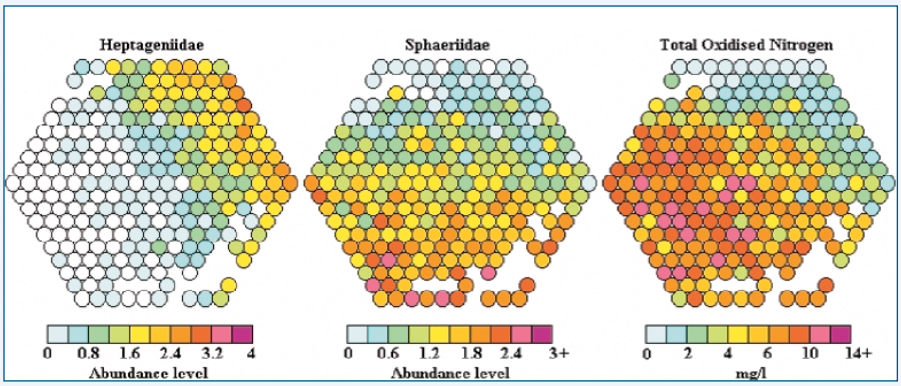
The Centre for Intelligent Environmental Systems (CIES), Staffordshire University, UK, specialises in the application of artificial intelligence (AI) to problems affecting the natural environment. Projects to date have concentrated on the development of intelligent systems for the biological monitoring of river quality, with the Centre's expertise in this field growing out of the pioneering work carried out by Bill Walley and Bert Hawkes in the early 1990s.

Biological monitoring of river quality has grown in importance over the past few decades and the approach now underpins legislation recently introduced in the EU, the Water Framework Directive (WFD). According to the WFD all freshwater bodies should be classified in terms of their ecology, with the target of reaching at least 'good' ecological status by 2015. The objective for CIES in the last few years has been to develop robust models for the interpretation of biological and environmental variables in terms of water chemistry and vice versa. Diagnosis is a key function; that is, determining likely pressures such as organic pollution, excess nutrients or acidity, from biological and environmental data. Prediction is also required; that is, forecasting the biological response to changes in pressures, perhaps as a result of modifications to land use or the treatment of waste water. Both of these functions are of fundamental importance for meeting the requirements of the WFD.

The methods used by CIES stem from the belief that experts use two complementary mental processes when diagnosis or prediction is required, namely probabilistic reasoning based upon their scientific knowledge; and pattern recognition based upon their experience of previous cases. Consequently, the group has followed two lines of AI research in parallel - probabilistic reasoning based on Bayesian methods and pattern recognition based on neural networks and information theory.

The robust and holistic nature of Bayesian belief networks (BBNs) makes them well-suited to modelling complex systems, like river ecology, where the interaction between the elements is probabilistic in nature. This uncertainty is represented explicitly in the model by probability distributions that encode cause-effect relationships. CIES has used BBN technology to develop, in collaboration with the Environment Agency for England and Wales, a model of river ecology called RPBBN (River Pollution Bayesian Belief Network). The strength of this approach has been that the model can be used to diagnose the pressures that affect a site and/or predict the ecological changes resulting from a programme of remedial measures.

The group has also developed its own pattern recognition system, MIR-Max (Mutual Information and Regression Maximisation), based upon information theory. This is now central to its pattern recognition systems and forms the basis of an application called RPDS (River



Distributions of three variables across an output map. The first two are biological variables (a mayfly and a snail) and the third is a chemical variable.

Pollution Diagnostic System) that was developed for the Environment Agency. RPDS uses MIR-Max to categorises n-dimensional biological and environmental data into 'clusters' so that each cluster contains data samples that are similar. The clusters are then ordered in a two-dimensional hexagonal output 'map' so that similar clusters are close together. Since each cluster represents a particular set of biological and environmental variables, and a set of associated chemical variables, the map provides a powerful diagnostic system and data visualisation tool for examining patterns and relationships in the data (see Figure).

The current work of the group is focussed on integrating the BBN and pattern recognition approaches into a single system. This system, due for completion in 2007, will offer enhanced capacity for diagnosis, prediction and classification, and will provide decision support for those responsible for river management in England, Wales and Scotland.

Although bio-monitoring remains the principal application domain, the work of the group has diversified into other environmental applications such as oil-spills on inland waters. The Oil Pollution Diagnostic System (OPDS) is a prototype computerised diagnostic tool designed to help the Environment Agency to determine the type of oil product involved, then to "fingerprint" it to identify its source and to provide solid evidence for legal proceedings against the polluter. This is based on detailed matching of patterns in the gas chromatograms of the pollutant and the original product, after allowing for the effects of weathering. The pattern matching techniques of the OPDS can assist scientists in cases where the chromatograms are particularly complex and matches are hard to achieve.

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Mathematical Models for the Simulation of Environmental Flows: From the Strait of Gibraltar to the Aznalcollar Disaster

by Carlos Parés, Jorge Macías, Manuel J. Castro and José M. González-Vida

The realistic simulation of environmental flows is a subject of major economic, social, human and scientific interest. Human interaction with natural flows, through adding pollutants or being responsible for disasters such as the dam-break of Aznalcollar, feeds the necessity for numerical modelling and prediction.

The DAMFLOW project is looking at the development of efficient techniques for the numerical solution of hydrodynamic flows, with a particular focus on environmental applications. Among the project's aims is the development of robust and reliable numerical tools with low computational cost, which can predict and simulate hazards or emergency situations such as floods or oil spills. These numerical models may also assist, in some particular cases, in understanding the physical nature of the problem and the key processes involved.

Currently, a set of fascinating problems has attracted our attention. One of these is the two-layer water masses exchange through the Strait of Gibraltar. The confinement of the flow by a strait can give rise to profound dynamic consequences including choking or hydraulic control, a process similar to that by which a dam regulates the flow from a reservoir. The funnelling geometry can lead to enhanced tidal modulation and increased velocities, giving rise to local instabilities, mixing, internal bores, jumps and other striking hydraulic and fine-scale phenomena. In short, sea straits represent choke points which are observationally and dynamically strategic and which contain a range of interesting processes. The flow configuration in the Strait of Gibraltar is characterized by two counter-currents: at the

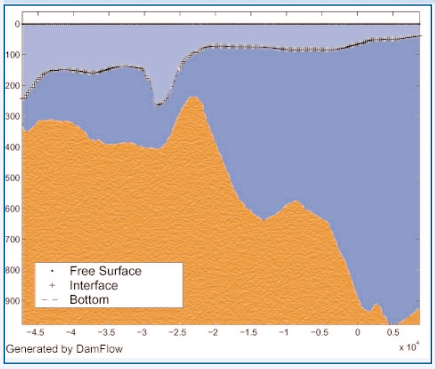

Figure 1: Two-layer 1D model showing the simulated interface separating the deeper Mediterranean waters from the surface Atlantic waters in the Strait of Gibraltar. Caption corresponds to spring tide conditions one hour before low tide.

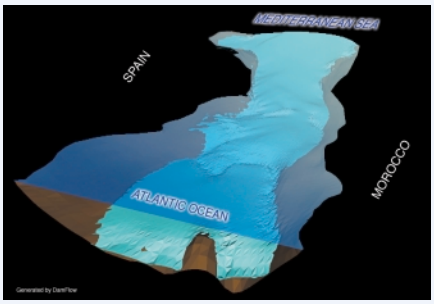

Figure 2: Two-layer 2D model showing simulated two-layer exchange flow through the Strait of Gibraltar.

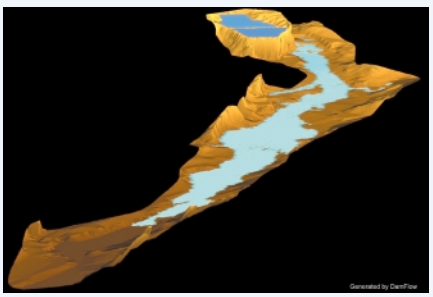

Figure 3: One-layer 2D model showing a simulation of the Aznalcollar dam-break. The flooded area is shown 2.5 hours after the dam-break.

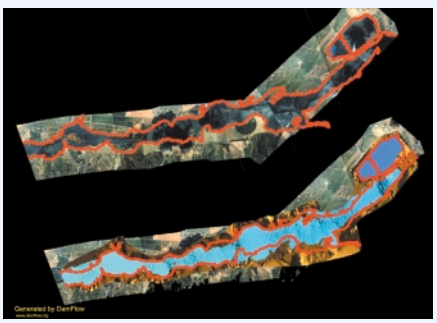

Figure 4: One-layer 2D model, again showing the Aznalcollar case; (above) digital model of the affected area, with the flooded area in red; (below) numerical simulation and comparison with the actual flood area.

surface the less saline water of the Atlantic flows eastward, spreading into the Mediterranean and, at depth, the waters of the Mediterranean flow westward toward the Atlantic Ocean. This situation means that it is possible and useful to use two-layer models to represent the region's dynamics and to better understand the key processes involved. As result of the DAMFLOW project, a set of finite-volume two-layer shallow water models have been developed, comprehensively tested, and used to numerically simulate the dynamics of the Strait of Gibraltar. One-dimensional tidal modelling of the Strait (see Figure 1) revealed a complicated pattern of time-dependent hydraulic fluctuations involving changing interfacial levels, moving control points and reversal of the layer flows at different stages of the tide, in good agreement with observations. Two-dimensional modelling (see Figure 2) produces a more complex picture of tidal dynamics for the interpretation of which several numerical and graphical tools have also been developed.

A second environmental problem that deserved our attention was the simulation of the Aznalcollar dam-break. On 25 April 1998, a massive spillage of tailings occurred from a pyrites mine lagoon at Aznalcollar (Seville, Spain) and damaged the environmentally sensitive Doñana region. This caused an estimated economic cost of 300 million euros and an unquantifiable cost in terms of environmental damage. Our project has focused on reproducing the Aznalcollar dam-break conditions in order to assess our model's performance. First, a digital model of the affected area was made from GIS data. A two-dimensional one-layer finite volume model was used (see Figure 3), which showed robust behaviour and produced good results; propagation speeds, the flooded area (see Figure 4) and draught sections were in good agreement with the available data. The model had previously been validated against test cases with analytical solutions and laboratory data. The results provided by the model have given us confidence that this numerical tool can produce and provide a full description of a potential flood wave and flooded area in other scenarios of potential risk.

At the present stage of the project:

- robust 1D and 2D finite-volume one- and two-layer solvers have been implemented, taking into account realistic topographical data
- an exhaustive model validation has been undertaken
- rigorous comparisons have been made with observed data
- input data for model problems were taken from observed measurements
- sensibility studies have been performed on various physical parameters such as friction or density ratio in oceanographic applications
- fortnightly and monthly signals have been investigated in model variables (Strait of Gibraltar).

Numerical modelling and simulation require, besides algorithmic research and implementation, the use of 'interfaces' and other technological developments. In the framework of this project we have also undertaken the following tasks:

- development of pre-processing, post-processing, analysis and visualization tools
- parallelization of the numerical schemes on a PC cluster, providing good efficiency
- use of mesh adaptation techniques.

This research is partially funded by the C.I.C.Y.T. (Comisión Interministerial de Ciencia y Tecnología), project BFM2003-07530-C02-02, which commenced in December 2003 and will end in December 2006. The research team involved in this project belongs to the Differential Equations, Numerical Analysis and Applications group at the University of Málaga. Close collaborations exist with the Numerical Analysis in Fluid Mechanics group at Seville University led by Tomás Chacón, and other research groups at the Universities of Santiago de Compostela, Zaragoza, Cádiz, I.E.O. (Spanish Institute of Oceanography), CITEEC (University of La Coruña) and Université de Corse (France).

Link:
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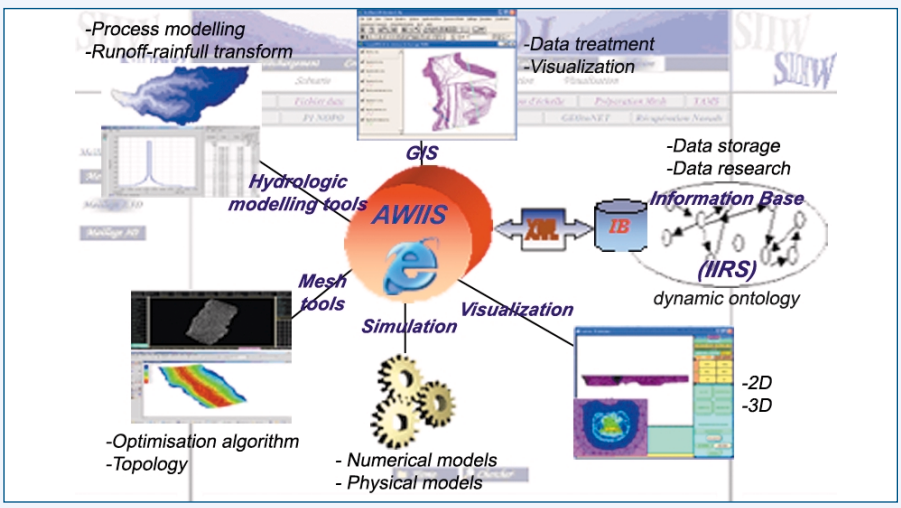
AWIIS: An Adaptive Web-Integrated Information System for Water Resources Modelling and Management

by Fadi El Dabaghi

The AWIIS is a Spatial Decision Support System for rational planning, operation and management involving water resources. It provides the user with a customized overview or partial view depending on the user profile and the use context. This is achieved through dynamic ontology, using the concept of relevance feedback and a thesaurus based on substitutes of documents.

The management of water resources is a highly complex and tedious task that involves multidisciplinary domains including data acquisition and treatment, multi-processes and therefore multi-models, numerical modelling, optimization, data warehousing, and the analysis of exploitation, socio-economic, environmental and legal issues. In addition, given water's vital role in human life, the continuous decrease in its availability due to over-exploitation and pollution, and its scarcity in arid areas, there is a clear need for better design and optimal use of hydro-systems. In this context, a rational analysis must be based on an approach that considers all related causes and effects and systematically evaluates the various alternatives. These include preserving water for irrigation, managing watersheds, building dams to alleviate the impact of floods and improve the water supply, simulating floods for risk prevention, oxygenating lakes to eliminate eutrophication, etc. For this, we have developed a Web-Integrated Information System (WIIS) dedicated to the management and modelling of water resources. This system is an infrastructure of development: perennial, open, modular, robust, effective and convivial, offering a complete, dynamic and configurable environment.

The WIIS architecture consists in two levels: the first contains general modules such as viewers, GIS, grid generators, a data warehouse and simulators, while the other is domain-specific and includes all the relevant modules tackling numerical modelling for the water-related physical application under study, ie hydrology, hydraulics, hydrodynamics and floods. This architecture is based on integration principles linking software components with heterogeneous data sources. Within this objective, we confront an important conflict. On the one hand, there is a considerable need for flexibility in the simulation of water phenomena and the representation and handling of input/output data, which are characterized by the absence of fixed and rigid structures. On the other hand, these data, exchanged within the WIIS, are a priori unstructured, heterogeneous and distributive, which means they are not easily accessible or exploitable. Within this framework, we looked at the definition of a model for the representation and structuring of the data using XML techniques. Accents were put on both the customization of the WIIS and its adaptation according to the user profile and the context of use.



Adaptive Web-Integrated Information System (AWIIS).

In the first stage, we led a pseudo-XMLization of all the data accessed or exchanged within the WIIS through an Information Indexation and Research System (IIRS). This IIRS operates on a thesaurus based on Substitutes of Documents (contains the essential information and description of the original document as well as a link to its real locality) under XML structure of the data warehouse, characterized by strongly heterogeneous and distributed contents. The second stage aimed at setting up an Adaptive Web-Integrated Information System (AWIIS), which is based on the WIIS and is robust and effective in terms of integrated tools and data. This AWIIS must provide a convivial, adaptive interface, rich in information, and possibly with an overview or various partial views according to the situation. This customization is closely dependent on the user profile and the context of use. The AWIIS will also integrate a PIRS (Personalized Information Research System), which generalizes on the IIRS. It should be dynamic and evolutionary, use the concept of relevance feedback, and its driving idea is the combination 'request-result-user'. This PIRS operates

on dynamic ontologies built around a thesaurus, which is based on substitutes of documents of our data warehouse.

All the components of the WIIS are built through Java intelligent interfaces within an appropriate user-friendly framework under a client/server application. They are portable on both Unix and Win platforms, and provide coherence in the distribution of data treatments and/or between client and server. The client prepares and sends requests to the server, a powerful Unix machine in terms of memory and input/output capacities, which provides direct access to a parallel computing machine or HPCN facilities. This platform allows inter-application navigation, cooperation between software and ease of use on the client and/or server station, cooperation between programs as an environment of development, and access to distant materials and software resources (eg real or virtual parallel machines, data, calling of remote procedures such as execution of heavy numerical codes on the UNIX server, storage etc). Hence, it permits users to carry out an efficient impact assessment analysis for sustainable development, while taking into account socio-economic, legal and environmental issues.

This work was supported by the WADI (Water Supply Watershed Planning and Management: An Integrated approach) Euro-Mediterranean Project and French bilateral cooperation programmes (CMIFM - Franco-Moroccan Cooperation: MA/01/03, CMEP - Franco-Algerian Cooperation: 01 MDU 529, and PLATON - Franco-Greek Cooperation : 05572UB). The WADI project was managed by ERCIM through a consortium consisting of INRIA-France, FORTH/IACM-Greece, EMI/ONEP-Morocco, ENP-Algeria, Calabria University-Italy and ESIB/CREEN/EUCLID-Lebanon.

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Numerical Modelling and Analysis of Water Free Surface Flows

by Fadi El Dabaghi

A number of environmental engineering applications related to water resources involve unsteady free surface flows. A full three-dimensional model based on Navier-Stokes equations can give good descriptions of the physical features of certain phenomena, including lake eutrophication, transport of pollutants, floods and watersheds. However these models are characterized by significant computational cost. We aim to reduce this through the use of two-dimensional models or appropriate coupling models of different dimensions.

The models developed in this context can be classified into two categories: a two-phase flow model based on Navier-Stokes equations, and a shallow-water flow model.

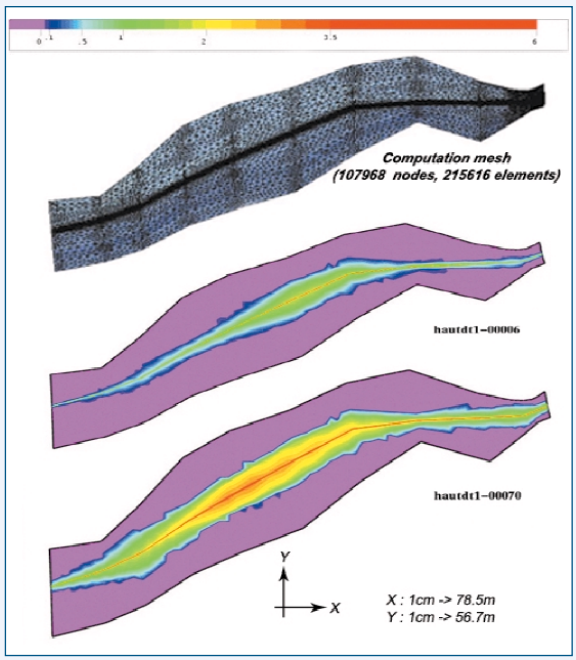
Two-phase flow models have been used to simulate the remedial aeration used to combat eutrophication effects in lakes. A water reservoir is generally considered eutrophized when the concentration of dissolved oxygen drops below 3 mg/L. The idea behind remedial aeration is to inject compressed air into the bottom of the reservoir in order to stir up and oxygenate the water. The numerical simulation of the resulting flow by conventional models such as the two-fluids or Lagrangian models leads to many difficulties. This is mainly due to the models' complexity and the need for a fine grid in order to achieve a good representation of the effect of the bubbles.

These difficulties limit interest in these classical models and lead us to suggest some cheap and realistic alternatives. We consider a one-phase flow model based on velocity-pressure semi-compressible Navier-Stokes equations. Here, bubble dynamics are taken into account, firstly through boundary conditions related to the air injection velocity at the aerator position, and secondly by introducing correction terms representing the forces applied by the bubbles to the water. In the same framework, a more general two-fluids (air/water) model with a moving water free surface has been developed. We use realistic assumptions regarding the wind velocity and the atmospheric pressure with a convection equation describing the void fraction function of the water, which determines the wet domain. This allows us to treat the free surface effects of the lake in a more suitable manner, and consequently improve the dynamic results of the bubbles' aeration effects.

The second category of model is the shallow-water model: these describe river flooding, tidal fluctuations, bay and estuary flows, breaking waves on shallow beaches etc. They are derived from 3D incompressible Navier-Stokes equations by depth-averaging of the continuum mass and momentum balances. These models, known also as Saint-Venant, involve fluid-domain geometries characterized by their complexity and variability, and the large-scale computational aspects and fine grid necessary for realistic simulations.

To overcome these problems, we have used a priori and a posteriori error analysis. Geometric error indicators have been derived to improve the numerical simulations models by adaptive mesh

techniques; these ensure an optimal quality solution at a required precision for a given computational cost. Moreover, the error indicators accurately predict in which parts of the fluid domain the flow model may be considered 1D, 2D or 3D, and can couple the resulting multi-dimensional models. In addition, we have integrated a conceptual hydrological model based on the HEC-HMS: this model computes run-off volume by subtracting the volume of water that is intercepted, infiltrated, stored, evaporated, or transpired from the precipitation in the catchment area. The result of this step, a flood hydrogram, forms the boundary conditions for the numerical models presented above (St-Venant) in simulating the flood.



Water depth iso-values during flood. Foum Tillicht river, Morocco 1988.

From the numerical point of view, the approximation of the models mentioned above is based on the characteristics method for the time discretization of the advection terms. This method leads to an upwind scheme, which has the double advantage of being physically closed to convection, and being an explicit scheme unconditionally stable in the finite element context, thereby allowing the use of large and reasonable time steps. At each time level, we have to solve a quasi-Stokes problem, approximated by P^1/P^1 mixed finite elements for the velocity-height St-Venant formulation, or by (P^1 + bubble /P^1) mixed finite elements for the velocity-pressure Navier-Stokes formulation. This ensures the discrete LBB condition necessary in this context. For both formulations, the a priori error estimates are verified numerically on many academic test cases before the models are validated on real cases such rivers in flood or crossed 2D lake sections. Moreover, given that the real-time and large-scale computing requirements are very important for this kind of simulation, we used the HPCN facilities; this permitted the execution of developed codes, particularly on real test cases requiring finer and more complex meshes.

This work was supported by many Euro-Mediterranean projects (WADI , ESIMEAU and CruCID) and French bilateral cooperation programmes (CMIFM , CMEP and PLATON). The EU projects were managed by ERCIM through a partnership constituted by INRIA-France, FORTH/IACM-Greece, EMI/ONEP-Morocco, ENP-Algeria, ENIT-Tunisia, RIKS-Holland, Calabria University-Italy and ESIB/CREEN/EUCLID-Lebanon.

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SACADEAU: A Decision-Aid System to Improve Stream-Water Quality

by Marie-Odile Cordier

Water quality is a critical environmental issue. In this project, we use a pesticide transfer model to simulate effects on the quality of stream-water. Since a large number of parameters are involved in pollution phenomena, modelling, simulation and machine learning are useful techniques for acquiring knowledge in this poorly understood domain.

The objective of the SACADEAU is to build a decision-aid tool to help specialists in charge of catchment area management to preserve stream-water quality. This is done by coupling a qualitative transfer model (simulating pesticide transfer through the catchment area) with a qualitative management model (simulating farmers' decisions concerning weeding strategies and herbicide application). This has two main advantages: it allows the impact of recommendations to be evaluated by simulating high-level scenarios, and it allows simulation results to be analysed by using machine learning and data mining techniques to discover discriminating variables and to acquire knowledge in this poorly understood domain.

The experimentation site (the Fremeur catchment area) is located in Brittany, France and covers about seventeen square kilometres.

A Transfer Model Coupled with Three Input Models

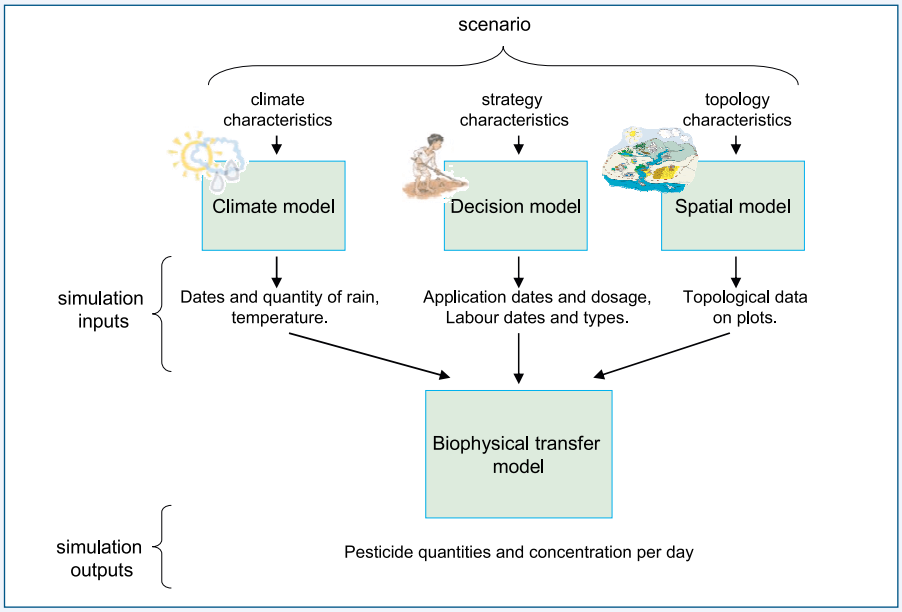
The transfer model simulates river contamination by pesticides. It models pesticide transfer through a catchment

area and simulates the daily river contamination that this causes. This phenomenon depends on numerous parameters, including human activities, climate, soil type and catchment area topology. Since these parameters are complex and difficult to formalize, we created three sub-models to describe them (see Figure).

These are as follows:

- A decision model, which models farmers' strategies. This provides herbicide application characteristics (date, substance, quantity) and agricultural interventions (soil preparation, seeding date, weeding dates) according to predefined farmers' strategies and weather conditions.
- A climate model, which provides daily weather data such as the temperature and the quantity of rainwater.
- A spatial model, which is in charge of the spatial distribution of agricultural activities, according to the catchment area topology.

Using the outputs of these three sub-models, a biophysical transfer model determines pesticide transfer from application locations, through the catchment area, to the river. The model takes into consideration all the possible ways in which rainwater can flow through the catchment area (run-off and leaching).



The four components of the pesticide transfer model in a catchment area.

A High-Level Language

In order to achieve qualitative results, a high-level language for inputs and outputs of the model is required. The aim is to describe qualitatively, via a scenario, numerical inputs and outputs of the model. This can be seen as the process of discretization of quantitative data. This process is fundamental if we want to construct comprehensive results for decision-makers. The initial step was to gather a set of scenarios suggested by experts; for example, "What happens if a post-emergence weeding strategy rather than a pre-emergence strategy is applied on all plots close to the river?" or "What is the impact of pesticide application dates on stream-water quality?"

To simulate a scenario, a methodology was defined that consists in generating a large set of instances of the scenario. These instances are then simulated and the results generalized to give a qualitative description (in response to a qualitative question) using machine-learning techniques. For example, given the question above concerning the impact of application dates, a response could be: "Concentration peaks appear when pesticide application dates are close (less than two days) to significant showers (quantity > 10mm)".

Learning from Simulation Results

The global model generates pesticide quantities and concentrations according to the parameters mentioned above. The set of simulation inputs and outputs is called an example in machine-learning vocabulary, and the set of examples is the set of instances of a scenario we have simulated. We used the inductive logic programming software ICL (http://www.cs.kuleuven.ac.be/~wimv/ICL/) to learn a set of rules summarizing the examples. These rules can be formatted according to the task being addressed. For example:

- qualitatively predicting water pollution
- identifying which variables play an important role in water pollution
- characterizing important risks (eg whether pollution is due to too many concentration peaks, or to a constant and significant source of pollution).

First results have been obtained with a simplified model, and according to the experts, they show both expected and surprising relationships. For instance, concerning stream-water quality, a post-emergence weeding strategy did not show better results than a pre-emergence strategy. This was unexpected, and a discussion on the impact of weeding strategies was generated, with some possible explanations given by experts.

Future work is three-fold, and involves validating the model, refining the high-level language, and providing recommendations to experts based on relationships discovered through the model.

The SACADEAU project is in its third year of development. Contributing members are M. O. Cordier, V. Masson, A. Salleb (IRISA/Univ. Rennes 1, Rennes), C. Gascuel-Odoux, F. Tortrat, P. Aurousseau, R. Trepos (INRA-ENSAR/UMR SAS, Rennes), F. Garcia (INRA/BIA, Castanet Tolosan), B. Chanomordic (INRA/LASB, Montpellier), M. Falchier, D. Heddadj and L. Lebouille (Chambre d'agriculture de Bretagne). SACADEAU is funded by Conseil Général du Morbihan and INRA.

Link:
http://www.irisa.fr/dream

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Developing an Environmental Modelling Framework for Integrated Assessment of EU Agricultural Policies

by Andrea E. Rizzoli, Carlo Lepori, Roberto Mastropietro and Lorenzo Sommaruga

'SEAMLESS', System for Environmental and Agricultural Modelling; Linking European Science and Society, is an environmental modelling project aimed at creating a framework, named SEAMFRAME, which is specifically targeted for integrated assessment in the agricultural domain. The goal is to deliver a software toolkit to facilitate the comparison and integration of the many different models in existence today.

European agriculture is currently undergoing radical changes due to economical pressures imposed by the enlargement of the EU, the revision of WTO agreements, and changes in farm support payments. Such changes interact with the physical and natural environment (eg, climate change, loss of biodiversity). Meanwhile, society demands a green and clean landscape, and farming communities in rural areas are faced with continuous technological innovation.

Scientists and modelers are therefore confronted with the increasing need to deliver scientific results, which can be used by policy makers to assess new policies, at the regional and national scale, that can facilitate agriculture's contribution to sustainable development. The process of evaluation of a policy with respect to the three components of sustainable development (environment, economy, society) requires what has been defined 'integrated assessment' (Parker et al. 2002).

Yet, the obstacles to performing integrated assessment studies are substantial, given the dimension and the complexity of the problem. Integration requires that researchers from different disciplines merge and compare their ideas, often scaling up and down the dimension of the problem under study. For instance, in the case of the integrated assessment of agricultural policies, the effect of a subsidy for a given product has a different impact in the various regions, and the related change in farm activity has a very local effect on the environment.

Science, through innovation and research, has progressively built a vast body of knowledge specific to various sectors, which can now be considered as components of an integrated system. For instance, for a given crop growth process, there may be tens of different formulations solving the same modelling problem. Thus, the main issue becomes to make this knowledge accessible and re-usable. In fact, computer models are monolithic, difficult to reuse in a different context, and strongly tied to the modelling domain and scale of resolution. For this reason, many groups have been researching the problem of model integration and modelling frameworks to allow a 'seamless' and transparent model integration and re-use across different scientific domains and scales (eg, OpenMI (http://www.harmonit.org/), TIME (http://www.toolkit.net.au/), OMS (http://oms.ars.usda.gov/) just to cite a few).

A modelling framework is basically a software environment that supports the development of models, but it also provides a set of facilities to set up model runs, data visualisation and analysis, documentation, archival and discovery of models. A modelling framework also supports the packaging of end-user applications, which can be effectively used to support decision making. An environmental modelling framework adds domain-specific knowledge that enables solving environmental-related issues, for instance, it considers spatial modelling.

A snapshot taken at the SEAMLESS kickoff meeting, January 2005.

A new Integrated Project "SEAMLESS: System for Environmental and Agricultural Modelling; Linking European Science and Society" aims to develop an environmental modelling framework, named SEAMFRAME, which is specifically targeted for integrated assessment in the agricultural domain. This project was defined as a result of a research call from the European Commission within the EU 6th Framework Programme (Global Change and Ecosystems).

SEAMFRAME will capitalise on previous research in the development of environmental modelling frameworks. Moreover, it will support a 'declarative' approach to modelling (Muetzelfeldt and Massheder, 2003). A clear-cut separation between model representation (equations) and model manipulation (data processing, integration routines) will allow the effective re-use of the model in different contexts. The model equations will be semantically denoted, by means of Semantic Web technologies such as RDF and Ontologies. This will open the model structure to automated processing, leading to the possibility of searching models according to their specifications --- and model linking and composition will be greatly facilitated. Finally, another distinctive feature of SEAMFRAME will be the component-oriented approach of its software architecture. Declarative models will be deployed as software components, which can be manipulated by tools such as calibrators, simulators, optimisation routines, which are themselves software components. The use of introspection (Rahman et al. 2004) will allow tools to adapt to the published interface of models, thus granting the required flexibility and extensibility of the framework.

Thirty research institutions from thirteen European countries, including several new member states, are involved in the project. These institutions bring together a vast amount of knowledge and expertise from economic, environmental, agronomic, social and information technology disciplines. The project also includes co-operation with an African and an American research institute. The total budget is 15 million Euros. In 18 months the first prototype should be available and in four years the system should be fully operational. The project is coordinated from Wageningen University (The Netherlands), while the development of SEAMFRAME is coordinated by the Swiss institute IDSIA, part of USI (University of Lugano) and SUPSI (the University of Applied Sciences of Southern Switzerland).

Link:
SEAMLESS website:
http://www.seamless-ip.org

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Image Processing for Forest Monitoring

by Josiane Zerubia and Paul-Henry Cournède

Aerial and satellite imagery have a key role to play in forestry management. The increasing availability of data and their high spatial resolution, which is now submetric, allow automatic tools to be developed that can analyse and monitor forests by accurately evaluating the vegetation resources. The Ariana research group at INRIA Sophia Antipolis, with its strong experience in remote-sensing image analysis and feature extraction, is working on this topic as part of the joint research effort Mode de Vie.

Digitized aerial photographs and satellite images of forests represent convenient data for developing computerized assessments of forestry resources. Such automatic tools are useful for a number of reasons, including the help with which they provide forest managers in classifying species. Such work is currently done by specialists, using difficult image analysis combined with ground verifications. Some tools already exist for this purpose, and use texture information and classification based on parameters such as covariance matrices. However, few take advantage of high data resolution. Nowadays, it is possible to study forests on the scale of individual trees, by resolving the extraction of tree crowns. This is one of the aims of the Ariana research group, which in the last year has adapted its knowledge in stochastic geometry (object processes) to forest-resource evaluation. This will allow the automatic assessment of economically and environmentally important parameters such as the number of tree crowns, the distribution of their diameters or the stem density.

Our approach consists in modelling the forestry images as realizations of a marked point process of trees. This stochastic framework aims at finding the best configuration of an unknown number of geometrical objects in the image, with respect to a probability density defined a priori. This density takes into account both the data, in order to fit the objects to the feature we want to extract, and the interactions between these objects, to favour or penalize some arrangements. In the case of tree-crown extraction, we modelled the trees as ellipses, defined by the position of their centre, their orientation, and their major and minor axes. After simulation, we obtain a collection of objects and have access to several statistics such as the number of trees in the stand, their position and their diameter. If different species coexist, we can add a mark to the objects to describe their type, and obtain a classification during the extraction. Some tests have been performed on digitized aerial photographs of stands of poplars, courtesy of the French Forest Inventory (IFN). These photographs are taken in the infrared, which enhances the chlorophyll matter of vegetation. In future investigations, we will be studying texture parameters in order to distinguish different species during the simulation, and lower-level information to obtain a pre-segmentation of the image before the extraction process.

Another application relevant to forest monitoring has been developed by Ariana in collaboration with Alcatel

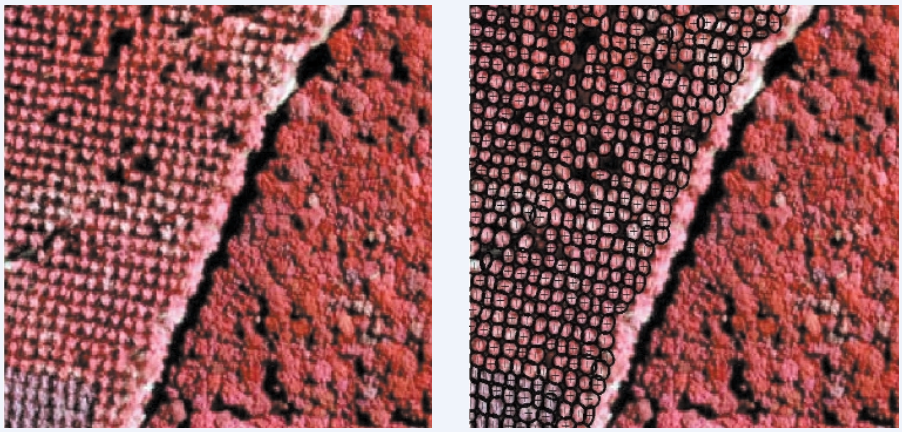

Figure 1: (left) In the original image (courtesy of IFN), the plantation of poplars on the left-hand side can be isolated thanks to a Gabor filter; (right) the result of the extraction process by stochastic geometry (Guillaume Perrin).

Space, and addresses forest-fire detection on satellite images, using the random fields theory. It consists in modelling the image as a realization of a Gaussian field, in order to extract rare events like potential fires that could grow and imply serious damage. For this purpose, the thermal infrared channel (TIR) is selected, since fires show up as peaks of intensity at these wavelengths.

Of further interest is the involvement of Ariana in the ARC joint research effort Mode de Vie, in collaboration with MAS Laboratory (Ecole Centrale Paris), the Digiplante research group (INRIA Rocquencourt, CIRAD), and LIAMA (Sino-French Laboratory of Informatics and Automation, Academy of Sciences, Beijing, China). The purpose of this joint action is to link the assessment of forestry resources with the dynamical models of plant growth developed in Digiplante and LIAMA. The ultimate target would be to develop a complete tool for vegetation monitoring, which could both evaluate the present biomass and predict its evolution.

Links :
http://www.inria.fr/ariana

http://www.inria.fr/recherche/equipes/digiplante.en.html

http://www.mas.ecp.fr

http://liama.ia.ac.cn

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GreenLab: A Dynamical Model of Plant Growth for Environmental Applications

by Paul-Henry Cournède and Philippe de Reffye

Some of the most critical issues for sustainable development and the protection of the environment concern the rationalization of agriculture and forest exploitation. For this purpose, a research project at INRIA, DigiPlant, aims at developing both mathematical models of plant growth and related computing tools. Over the years, an important Sino-European collaboration has emerged, involving research institutes and universities, mathematicians and biologists.

The cultivated areas of Europe, including agricultural land and exploitation forests, have a strong impact on global environmental conditions. Erosion, resource impoverishment due to over-exploitation, and pollution by fertilizers or pesticides are crucial problems that agronomy and forestry hope to solve through harmonious cultivation modes and exploitation strategies. For this purpose, they must take into account production needs on one hand and the environment on the other; that is to say, both quantitative and qualitative criteria. In this context, mathematical models of plant growth describing interactions between the architecture of the plant and its physiological functioning have a key role to play. They allow the exchanges (of water, carbon, minerals etc) between plants and their natural environment to be quantified.

GreenLab is just such a functional-structural model, and is the result of a long dialogue between botanists, physiologists and mathematicians. Derived from the AMAP model developed in the 1990s at CIRAD, GreenLab's new formulation was introduced at LIAMA (Beijing) in 2000. Today, the model is studied and improved upon through the DigiPlant project, which is run by a joint team of researchers from INRIA, CIRAD and Ecole Centrale Paris, and hosted by INRIA. Some very close partnerships exist with LIAMA, China Agriculture University, Wageningen University, Orsay University and INRA.

A number of choices have been made in order to simplify biological knowledge and write the dynamical equations of growth. Organogenetic growth cycles are defined, and an automaton describing the evolution of the buds determines the plant architecture. The botanical concept of physiological age, defining a typology

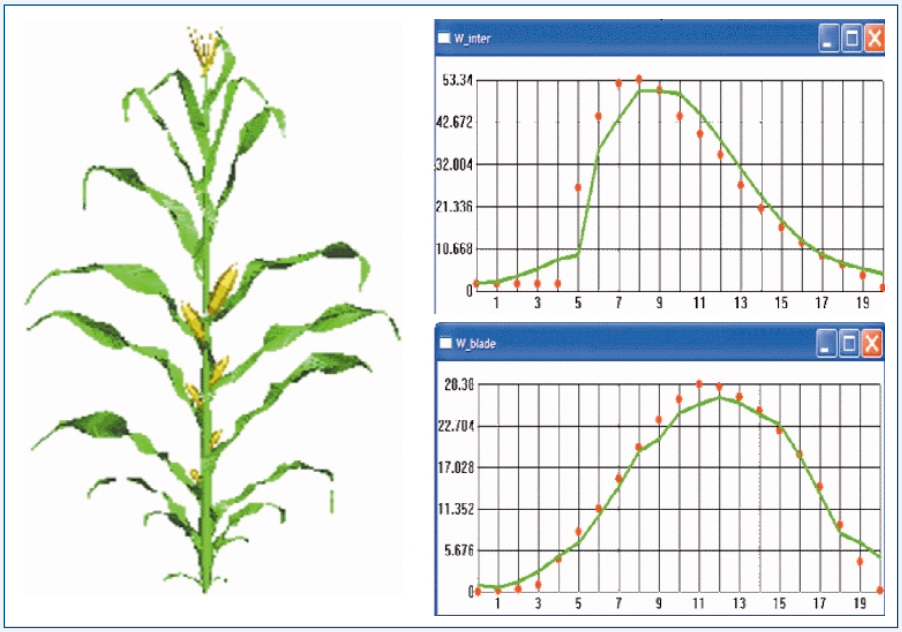

Figure 1: Fitting results obtained on maize data from China Agriculture University (Ma Y.T.); (a) simulated maize, (b) internode weights, and (c) leaf weights. Red dots represent experimental data and green lines simulated data.

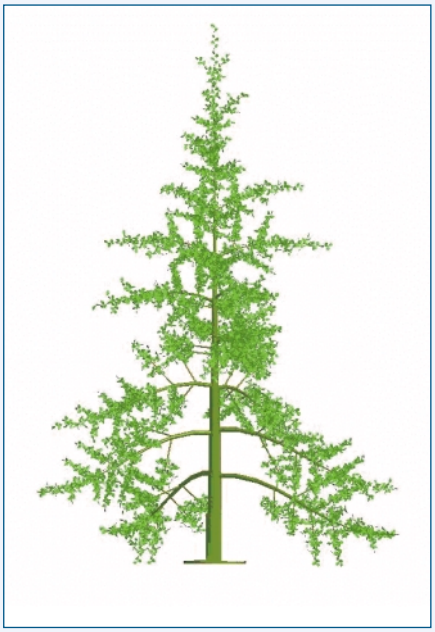

Figure 2: Architectural and physiological growth of a gingko tree (Kang M.Z.).

of the axes, allows a powerful factorization of the plant structure. Fresh biomass production is computed from transpiration and is then distributed among expanding organs (including buds) according to their demands (sinks). The available biomass determines the rules of the organogenetic automaton and the organ sizes, and plant architecture has a strong influence on photosynthesis. Thus, there is a very strong coupling between the growth equations.

Stresses are also taken into account, especially for environmental resources. In particular, we have studied the competition between plants for light and water in plantations or crop fields. Plant density is also an important control parameter of the model.

The introduced mathematical formalism had a significant impact on the model analysis. First, the simulation software is strictly derived from the mathematical formalism. Thanks to the structural factorization, the computation time grows linearly with the chronological age of the plant (in comparison with a bud-by-bud simulation whose computing time grows exponentially with the plant's chronological age). Moreover, the mathematical study of the system allowed theoretical results on plant viability and yield prediction to be obtained. The best prospects, however, rely on our ability to clearly formularize optimal control problems and to fit the theoretical models to real plants. These two points are the keys to applications in agronomy and forestry.

The hidden parameters of the model are very few (for example, twelve for an annual plant like maize). Agronomic data on maize, sunflowers, tomato, rice and wheat have been fitted with very good accuracy, and fittings on different plants of the same type have shown that the parameters are very stable. Some more complex plants like coffee, cotton and young beech trees are currently being studied.

We have developed tools for a variety of objectives:

- Optimization and control of the cultivation modes: in the case of limited resources, there is an optimal strategy of fertilizing and watering during plant growth. Likewise, controlling plant density or partial forest clearings can be beneficial. In this way, we can improve water resources and land management and reduce pollution by fertilizers.
- Control of plant sanitation and pesticides treatment: by coupling the plant-growth model and insect-population dynamics, we can control the use of pesticides and thus reduce costs and pollution.
- Selection of crop variety: we are currently working with geneticists, in order to prove that the plant genes directly determine the physiological parameters of the GreenLab model. In this way, we expect to propose better strategies for crop selection.
- Virtual simulation and visualization of plantations: computer graphics techniques allow the results of numerical simulations to be visualized. This is very important in urbanism or landscaping for predicting the long-term evolution of projects.

The results of this research seem to show that in the near future, new tools of prediction, optimization and control could be effectively used in agriculture and forest exploitation on a large scale, and would drastically improve the management of the environment.

Links:
http://www.inria.fr/recherche/equipes/digiplante.en.html

http://www.mas.ecp.fr

http://amap.cirad.fr

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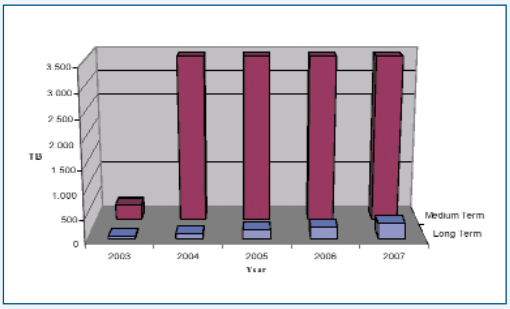
Lossless Compression of Meteorological Data

by Rodrigo Iza-Teran and Rudolph Lorentz

Weather forecasts are getting better and better. Why? The models include more physical processes and resolution has been improved. The consequence: more data is generated by every weather forecast. Much more data. Very much more data. What does one do with all this data? Answer: compress it.

In the Department for Numerical Software (NUSO) at the Fraunhofer Institute for Algorithms and Scientific Computing (SCAI), a new group has been founded to look at the compression of data resulting from numerical simulations. One of the fields in which it has been active is the compression of meteorological data. The motivation was the drastically increased amounts of meteorological data needing to be stored. This is a consequence of improved weather models and of the higher resolution with which forecasts are being made. However the data is also being used for new purposes: direct sales, data-mining and reanalyses. All of these tend to increase the amount of data that is archived for longer periods of time.



Planned archive size, German Weather Service.

The initial impetus was provided by the plans of the German Weather Service (Deutscher Wetterdienst) to switch from their Local Model (LM) to the Local Model-Europe (LME). This new model not only covers a larger area but also has a higher vertical resolution. The amount of data they plan to archive can be seen in the graph below. Medium-term storage requirements, ie for about a year, are planned to be just short of 4 Petabytes. That is 4,000,000,000,000,000 bytes.

Compression

Compression involves changing the form of data in a file, so that the compressed file takes up less space than the original file. There are two types of compression: lossy and lossless. If the compression is lossy, one cannot retrieve the original file from the compressed file. The advantage of this approach is that the data can be compressed to a much greater degree. Lossy compression is typically used to compress graphic and video files, especially in the context of the Internet. Typical lossy compression programs are JPEG and MPEG, which can reduce the size of a file by factors of ten to fifty.

On the other hand, if lossless compression is used, the original file can be retrieved exactly from the compressed file. Lossless compression is typical for text files, but also for files containing sensitive numerical data, eg medical or meteorological data. All Zip utilities perform lossless compression, with compression factors of around 1.5 to 3.

Meteorological data is typically stored in the GRIB format. This format, gridded data in binary form, is an international standard for the storage and exchange of meteorological data. The usual procedure is to first put the data obtained from a weather forecast into the GRIB format. This is lossy compression. Afterwards, however, any compression is required to be lossless. The new group established at SCAI has developed a program, GRIBzip, for the lossless compression of meteorological data stored in the GRIB1 format (ie GRIB Version 1). As an example, if the data is formatted in GRIB1 with 16-bit precision, then the GRIB files produced by a typical weather forecast can be reduced in size losslessly by, on average, a factor of three. Extrapolating this to the example of the German Weather Service, storage would be required for only 1.5 Petabytes of data instead of 4 Petabytes.

Archiving data in a compressed form has another advantage that may not be immediately apparent. Normally the archiving system consists of hardware separate from the other computers, meaning the connection to the archiving system can be a bottleneck. By using compressed data, the bandwidth of the connection is effectively increased by the same factor as the data has been compressed. In our example, the bandwidth would be effectively increased by a factor of three. A patent for the techniques used in the program has been applied for.

Future Activities

The programs developed in SCAI can compress GRIB data on topologically rectangular grids. Other types of grids, such as a triangular grid covering the whole globe, or grids which become sparser towards the poles, are also allowed by the GRIB format. We are planning programs able to losslessly compress this type of data. In addition, spectral data is sometimes stored in the GRIB format, and its compression is also desirable.

The group has also developed programs for compressing data produced by crash simulations (Pamcrash, LS-Dyna) in the automobile industry. Since this data is defined on irregular grids, the techniques used are quite different from those for data on regular grids. Using the expertise gained from these extreme cases, the group intends to compress data resulting from other types of simulations.

Link:
http://www.scai.fraunhofer.de/nuso.0.html?&L=1

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Air-Quality Information for Multi-Channel Services: On the Air with Mobile Phones

by Gertraud Peinel and Thomas Rose

The APNEE project (Air Pollution Network for Early warning and information exchange in Europe) has designed customizable services providing information on air quality for citizens. These services draw on various information channels, including mobile technology, interactive portals for the Internet and street panels.

Based on such high-quality dissemination services, even environmental information becomes an attractive product once it is perceived as providing citizens with indicators of their levels of comfort. The APNEE information services are based on the following concepts:

- public sector information is promoted as catalytic content for new and compelling applications
- citizens require information on air quality in a user-friendly form
- EU directives are calling for new ways to disseminate information on air quality to citizens.

Authorities and scientists have large amounts of data with perfect means of visualization and well-researched models for calculation, forecasts and interpolations. Normally however, citizens are not targeted as potential consumers of these data. Yet citizens are now beginning to call for timely and high-quality environmental information for reasons of comfort and health care, especially when they are individually affected by respiratory diseases. While general information is available via Internet servers and TV video text, some things are still lacking:

- classification of measurement values by user-friendly indexes (ie 'good' or 'bad' instead of, say, 77 µg)
- information regarding health impact and what action to take
- appropriate channels through which to reach citizens on the move (ie anytime and anywhere).

To date, most warnings of adverse environmental conditions have made use of broadcast channels. However, radio or TV inevitably reaches a much larger audience than that section of the population actually at risk. National and regional authorities have found it difficult to 'narrowcast' specific environmental warnings or advice only to those living within a specific area. It is this capability that APNEE and APNEE-TU have implemented and tested by utilizing modern IT and telecommunication technology at locations across Europe.

Project APNEE commenced in January 1999 as an RTD project in the Fifth Framework Programme of the European Commission, IST Programme, Key Action I (Systems and Services for the Citizen), Action Line I.5.1. It concluded successfully in December 2001, and a take-up action named APNEE-TU (4/2003 – 3/2004) adapted and tested the APNEE systems at additional user sites in Europe, as well as employing new technologies (eg handhelds, smart phones, PDAs and new mobile protocols like GPRS) for the dissemination of air pollution information.

Field trials for the evaluation of these innovations in APNEE and APNEE-TU took place at nine test sites (Oslo, Greenland, Athens, Thessalonica, Marseilles, Canary Islands, Madrid, Andalusia, and the whole of Germany), and the projects included 21 partners

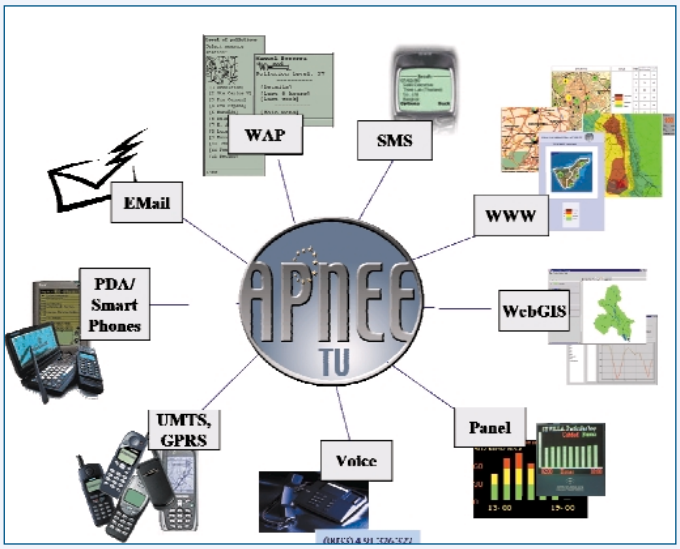

Figure 1:
Channels in APNEE and APNEE-TU.

Figure 2:
Partners and test-site locations in APNEE and APNEE-TU.

from research, government and the IT and telecommunications sectors. The test sites represent a diverse selection in terms of geography, pollution problems and cultural settings. In addition, their experience and development of air monitoring stations were different.

We designed and implemented the following 'business collaboration concept', which has proven successful:

- in each APNEE region an authority provides and authorizes the measured air pollution data
- research institutes and universities operate and control models for the forecasting of air pollution
- technological partners design and realize the Internet and WAP portals as well as street panel interfaces
- mobile and Internet information portal providers integrate the APNEE solution into their portals
- telecommunication companies distribute the messages through SMS, MMS and WAP, as well as via smart phones and PDAs.

APNEE is, first of all, the architecture of a dissemination platform, built around a harmonized environmental database scheme. In this respect, APNEE supports the harmonization of air-quality management systems. This eases the exchange of data (eg among authorities), allows further standardization of methods and directives and simplifies integration into other services and service providers. In addition, APNEE provides a reference implementation of components, required to set up an APNEE infrastructure at a new user site. APNEE is mostly based on royalty-free open-source software that has a very good developer community for support. It can be installed on a standard PC and is easily administrated once the set-up has been completed. The installation and operational costs of APNEE are very low, allowing cities and communities to set up an information portal for air-quality (or any other environment-related) information, even on a low budget.

APNEE created a set of reference core modules, including a common database scheme, service triggers, and regional server applications. These core modules are considered to be the heart of the system; however, they may be bypassed or not implemented in cases where only the electronic services are of interest for installation and operational usage, provided that there is a database and a pull-and-push scheme offered via alternative software infrastructures. Thus, the project's e-services pallet currently includes:

- pull services: WAP, J2ME, PDA, Internet-based, GIS information services, voice server
- push services: SMS, e-mail, newsletter
- street panels.

These services may be applied individually, in combination, or in parallel with other pre-existing services, where they exist.

The complementarity and in particular the context-awareness of services have proven decisive in reaching citizens, that is, in advising people of episodes that might cause harm to their health. MMS services sound attractive from a technology point of view and WAP services allow for more detailed information when on the move. Nevertheless, SMS services have proven sufficient in several field trials.

APNEE has been built upon the use of complementary communication channels. Having successfully completed the field trials, we now know which channels are best suited for various kinds of environmental episode. The information dissemination platform is distinguished by its customizability: messages can be customized to the location of users, their preferences or the types of content that affect them. This facility means APNEE excels in providing early warning of hazardous events. Recipients can be targeted in a focused fashion, with the type of message also able to be tailored.

The project was recently presented as a success story among IST projects by Commissioner Viviane Reding during a press conference in Brussels. Future applications of APNEE will be early warning services. We are currently working on risk management concepts and services for cities and urban regions.

APNEE was supported by the European Commission DG XIII under the 5th Framework Pro-gramme, IST-1999-11517. Partners included FAW Ulm, Germany (coordinator), Airmaraix, France, Aristotle University Thessaloniki, Greece, Ayuntamiento de Madrid, Spain, Expertel Consulting, France, NILU, Norway, NORGIT AS, Norway, Seksjon for kontroll og overvåking i Grenland, Norway, SICE, Spain, Telefonica I+D, Spain, Universidad Politecnica de Madrid, Spain. APNEE-TU was supported by the EC under contract IST-2001-34154. Additional partners are the Storm Weather Center and National Road Protection Agency, Norway, ITC Canarias and Andalusia Network, Spain, OMPEPT and Siemens, Greece, and UMEG, Fraunhofer FIT (new coordinator), and t-info GmbH, Germany.

Links:

Project Web site:
http://www.apnee.org

Spain:
http://panda.lma.fi.upm.es/andalusia
http://panda.lma.fi.upm.es/canary/
http://atmosfera.lma.fi.upm.es:8080/regional-eng/servlet/regional/template/Index.vm

Greece:
http://www.apnee.gr (temporarily out of order)

Norway:
http://www.luftkvalitet.info

Germany:
http://www.t-info.de
http://www.t-zones.de

France:
http://www.airmaraix.com

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Articles in this Section

Building a Bridge for Communication between Patients, Family Doctors, and Specialists

by Matteo Paoletti, Loriano Galeotti and Carlo Marchesi

According to recent reports of the World Health Organization, the next two decades will see dramatic changes in the health needs of the world's populations with chronic diseases, mental illness and injuries as the leading causes of disability. Increases in the senior population 'confined' within the home are also expected. ICT technologies must tackle this challenge by providing the means for fast communication and consulting services between the chronically ill, the general practitioner and the hospital specialist.

The objective of the AMICUS project, launched in 2003 at the BIM Lab, University of Florence, is to design a personalized communication system that can improve the quality of daily life and medical care for the chronically ill, at the same time helping to reduce the number and duration of hospital recoveries. AMICUS aims at contributing to the reduction of health costs and at providing easy access to medical assistance. This is in line with a recent position statement from WHO that strongly encourages the development of devices able to give patients an active, conscious role in the management of their disease: actions are needed that emphasize collaborative goal setting, patient skill building to overcome barriers, self-monitoring, personalized feedback, and systematic links to community resources.

AMICUS proposes a number of innovative solutions all aimed at increasing the control of patients over their health. First of all, patients should be encouraged to play an active role in monitoring their disease through the application of custom-designed procedures embedded in portable (possibly wearable) devices. In order to obtain the necessary medical and technical specifics for the implementation of devices of this type, AMICUS is studying the development of an instrument which will monitor the patient's vital signals and derive patterns of evolution over time. Although such devices are already potentially marketable, in our opinion a rigorous assessment phase is first needed in order to evaluate the level of knowledge and the experience necessary for a correct employment. Fully reliable systems are not yet available and a too-early introduction on the market could be dangerous. The AMICUS project will build a prototype system, known as COMPASS, which should offer wide possibilities of 'in itinere' intervention (hardware and software changes) as a result of experimentation and field trials. The system has a split architecture and consists of two units: one is a wearable Blue Tooth biosignal transmitter whose range covers the patient home area and the other is a PC work-station, which receives data from the patients and classifies events, submitting the information to the health care network, when necessary.

A second objective of the project is the definition of an accurate personalization of system parameters based on contextual information about the patient's case history and current dynamic conditions. A preliminary tuning is obtained on the patient's first admission, through a set of multivariate analysis techniques that

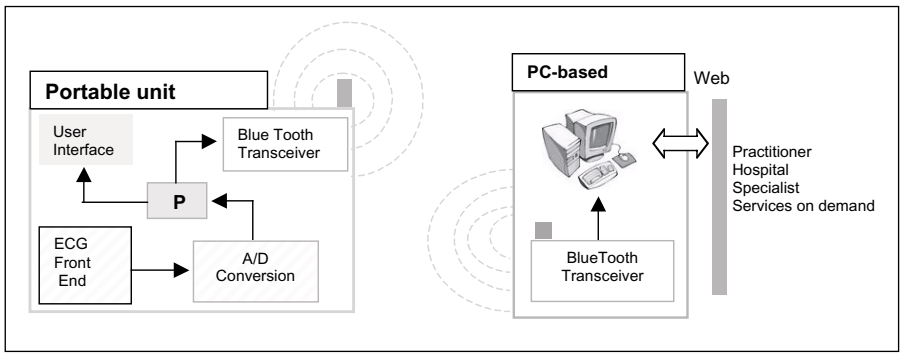
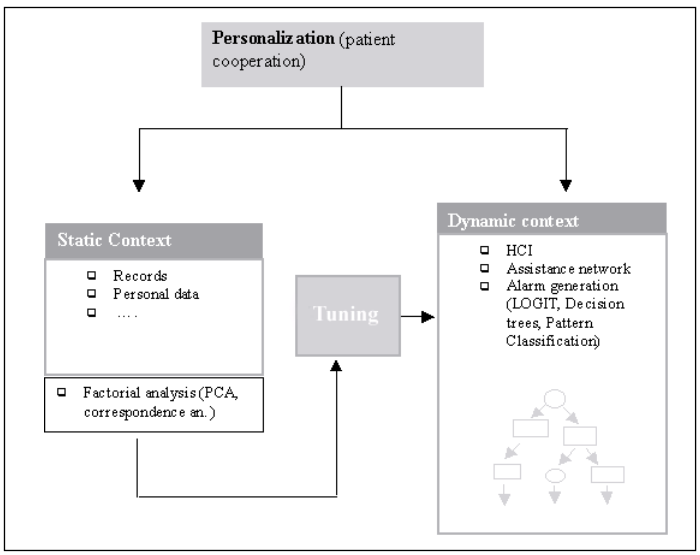


Figure 1: Split architecture (COMPASS project).

Figure 2: Personalization procedure.



indicate his/her profile (see Figure 2). This profile (or set of features) is embedded in the personalization procedure and the system's performance is then tuned accordingly.

Without the contribution of such contextual data, the signaling system would only be based on features derived from real time signals, which are usually not sufficiently reliable. On the contrary, the signals of the system can normally be correctly interpreted through human intervention. In our opinion, communication between a patient and his family doctor can be usefully supported by personal devices bridging the time interval between successive medical examinations.

An additional but important feature of the system regards a set of aesthetic and ergonomic values provided by industrial designers (ISIA, Industrial Design Institute of Florence).

We intend to begin experimentation of the system with a very well-defined group of patients. In this respect. we are currently talking to the Respiratory Unit of the Main Hospital in Florence with reference to the population affected by COPD (Chronic Obstructive Pulmonary Disease). On-line long-term monitoring could play an important role in the well-being of these patients. It could provide critical information for long-term assessment and preventive diagnosis for which trends over time and signal patterns are of special importance. Such trends and patterns are often ignored or scarcely identified by traditional examinations.

The aim of the operational phase (data acquisition and patient profile definition) will be to produce a system prototype. During the clinical trials we hope to discover the answers to questions like: How far can we rely on cooperation from the patient? Can the patient feel confident of a timely intervention? How simple must the system be to be accepted by a typical user? How easily would it be for specialists to abandon current patient admission practice? Would such an approach be useful in reducing the number and/or the duration of hospital recoveries?

Project partners:
- BIM Lab, DSI, University of Florence
- ISIA, Industrial Design Institute
- "Leonardo", General Practitioners Association
- Respiratory Unit, Critical Care Department, University of Florence
- SAGO s.p.a..

Link:
http://www.dsi.unifi.it/bim

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Connecting Remote Tools: Do it by yourSELF!

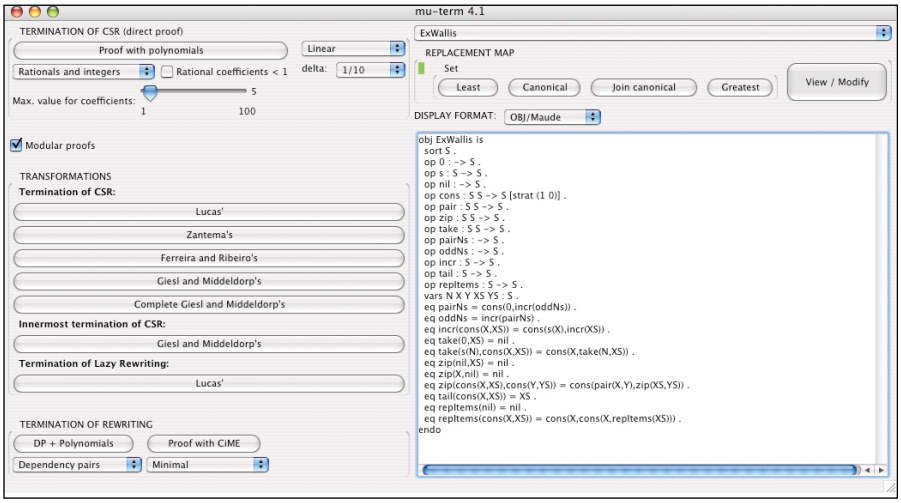
by María Alpuente and Salvador Lucas

Fifty years of research in computer science have seen a huge number of programming languages, theories, techniques, and program analysis tools come into existence. The World-Wide Web makes it possible to gain access to resources in a number of ways, ranging from remote downloads followed by local executions, to remote execution via WWW services. Unfortunately however, few of the existing systems and tools are effectively connectable, even if they address similar problems or rely on similar theoretical bases.

As recently noticed by T. Hoare, the quest for a verifying compiler is a classic, but still urgent problem for both the software industry and the computer science community. Of course, program verification, debugging and analysis (especially when oriented towards improving program efficiency) will be essential components of such a tool. Moreover, the effective development of such a system will require an incremental and cooperative effort from work teams all around the world. Thanks to the Internet, the physical distance separating those teams is becoming less and less important. Unfortunately, many existing systems and tools are not really suitable for working together, even if they address closely related problems or rely on similar theoretical bases. The Internet and middleware technology, however, provide numerous possibilities for removing integration barriers and dramatically improving the reusability of previous theoretical results and development efforts.

We can further motivate this point of view with two concrete examples extracted from our personal experience: model checking and termination analysis. Model checking is becoming a standard technique for automated software verification. Its success has made the term relatively popular for describing other verification methods. An example is the automatic analysis of general correctness properties of concurrent systems that do not require a particular representation with a property language (eg deadlock absence, dead code and arithmetic errors). Moreover, advances in model checking position it as an important contributor in the future development of the verifying compiler.

Still, model checking is not commonly used in, for example, object-oriented programming, where 'de facto' standard modelling methods (eg UML) and programming languages (eg C, C++ and Java) are common practice. The current pattern in verification tools for these languages essentially consists of automatic model extraction from the source code to the input language of existing, efficient model-checking tools like



Screenshot of the termination tool MU-TERM.

SPIN. However, the use of these tools for verifying parts of a program currently being developed in, say, Java is not easy. First, the syntax of Java programs does not correspond to the input language of any of the above-mentioned tools (eg Promela). Some translation is therefore required, but hardly covers a subset of the language. Second, there is no easy way of calling one of these tools from the Java interpreter. Third, we lack methods to analyse the results, especially counter-examples for non-deterministic executions. This is partly due to the different interfaces of the tools. For instance, in contrast to the usual GUI of most Java interpreters, SPIN has a command-based interface accepting text from the standard input (stdin), and writes its results on the standard output (stdout). Fourth, the tools can be written in different programming languages, which may make the eventual embedding of one tool into another significantly more difficult. Finally, there is no documented API to gain external access to the functionalities of the applications.

As a different (although related) motivating example, we consider the termination analysis of programs written in programming languages such as CafeOBJ, Elan, Erlang, Maude and OBJ, whose operational principle is based on reducing expressions according to the well-known paradigm of term rewriting. Proofs of termination of term-rewriting systems can be used to prove termination of such programs. A number of termination tools exist which can, in fact, be used to address this problem: for instance, the tool MU-TERM can be used to prove termination of simple Maude programs (see Figure 1). Termination of rewriting has also recently been related to certain classes of standard verification problems that can be reduced to termination problems.

Unfortunately, however, it is not easy to connect independently developed analysis tools (like MU-TERM) to a practical environment such as the Maude interpreter.

The problems are analogous to those enumerated above.

Interoperability (ie making it possible for a program on one system to access programs and data on another system) is a general problem in software engineering, and a number of solutions (namely, middleware systems) have been devised to solve it. The developers of (formal) software tools should consider such solutions to be an essential part of their design and development. Tackling this problem seriously would also be a positive step for the research community in formal methods and declarative languages. These areas are often used (or should be used) to design and implement analysis tools. By isolating the various aspects of a complex tool (eg GUI, numeric computation, constraint solving, program transformation and manipulation etc) into different modules possibly written in different languages, we gain the flexibility to use the most appropriate language. Tightly coupled support techniques such as RPC, CORBA and COM have not undergone sufficient experimentation and development in this setting. The XML WWW services (or just WWW services) also provide a flexible architecture for achieving interoperability of loosely coupled systems that are developed in different programming languages. Again, few efforts have been made to conciliate the design and development of software tools with this technology. We claim that, when considering the design and use of software systems and analysis tools, not only correctness and efficiency must be systematically considered but also interoperability across platforms, applications and programming languages.

Starting this year, we plan to develop these ideas into the research project SELF (Software Engineering and Lightweight Formalisms). This will include research on:

- Suitable XML-like formats for expressing the most important features of currently used (families of) programming languages. A related effort has been recently addressed for developing the CLI/CTS/CLS/CLR framework, which forms the basis of Microsoft's .NET platform.
- Suitable XML sub-languages for expressing analysis/verification requirements to existing tools.
- Middleware translators and interfaces from existing programming languages to the formalisms or lower-level languages which underlie the program analysis tools.
- The inclusion of existing verification and analysis tools into the SOAP/WSDL/UDDI framework of XML WWW services in order to gain systematic access to their functionality.

Links:
SELF: http://self.lcc.uma.es/

ELP group: http://www.dsic.upv.es/users/elp/elp.html

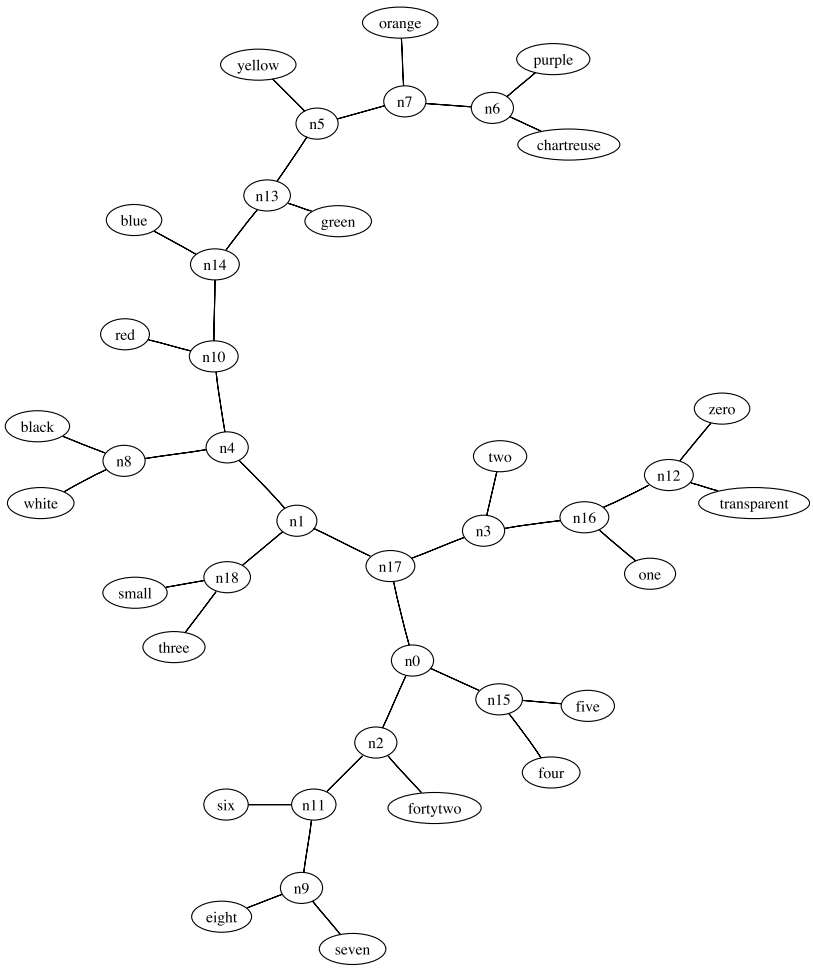
Please contact:
Salvador Lucas, Universidad Politécnica de Valencia/SparCIM
E-mail: slucas@dsic.upv.es
http://www.dsic.upv.es/~slucas

Google Teaches Computers the Meaning of Words

by Rudi Cilibrasi and Paul Vitányi

Computers can learn the meaning of words with the help of the Google search engine. CWI researchers Rudi Cilibrasi and Paul Vitányi found a way to use the World Wide Web as a massive database from which to extract similarity of meaning between words. The approach is novel in its unrestricted problem domain, simplicity of implementation, and manifestly ontological underpinnings.

To make computers more intelligent one would like to represent the meaning of words and phrases in computer-digestable form. Long-term and labor-intensive efforts like the Cyc project (Cyc Corporation) and the WordNet project (Princeton University) try to establish semantic relations between common objects, or, more precisely, names for those objects. The idea is to create a semantic web of such vast proportions that rudimentary intelligence and knowledge about the real world spontaneously emerges. This comes at the great cost of designing structures capable of manipulating knowledge, and entering high quality contents in these structures by knowledgeable human experts. While the efforts are long-running and large scale, the overall information entered is minute compared to what is available on the World Wide Web.



The program, arranging the objects in a tree visualizing pairwise NGD's, automatically organized the colors towards one side of the tree and the numbers towards the other.

The rise of the World Wide Web has enticed millions of users to type in trillions of characters to create billions of web pages of on average low quality contents. The sheer mass of the information available about almost every conceivable topic makes it likely that extremes will cancel and the majority or average is meaningful in a low-quality approximate sense. We devise a general method to tap the amorphous low-grade knowledge available for free on the World Wide Web, typed in by local users aiming at personal gratification of diverse objectives, and yet globally achieving what is effectively the largest semantic electronic database in the world. Moreover, this database is available for all by using search engines like Google.

We developed a method that uses only the name of an object and obtains knowledge about the semantic (meaning) similarity of objects by tapping and distilling the great mass of available information on the web. Intuitively, the approach is as follows. The meaning of a word can often be derived from words in the context in which it occurs. Two related words will be likely to give more hits — web pages where they both occurred — than two unrelated words. For instance, the combined terms 'head' and 'hat' will give more hits in a Google search than 'head' and 'banana'.

The Google search engine indexes around ten billion pages on the web today. Each such page can be viewed as a set of index terms. A search for a particular index term, say "horse", returns a certain number of hits, say

46,700,000. The number of hits for the search term "rider" is, say, 12,200,000. It is also possible to search for the pages where both "horse" and "rider" occur. This gives, say, 2,630,000 hits. Dividing by the total number of pages indexed by Google yields the 'Google probability' of the search terms. Using standard information theory, we take the negative logarithm of these probabilities to obtain code word lengths for the search terms — this 'Google code' is optimal in expected code word length, and hence we can view Google as a compressor.

We then plug in these code word lengths in our formula derived in a decade of theoretical and experimental work by others and us on compression-based similarity distances, to obtain the normalized Google distance or NGD, which represents the relative distance in meaning between the words The lower this so-called normalized Google distance, the more closely words are related. With the Google hit numbers above, we computed NGD (horse; rider): 0.443. The same calculation when Google indexed only one-half of the current number of pages gave NGD (horse; rider): 0.460. This is in line with our contention that the relative frequencies of web pages containing search terms give objective absolute information about the true semantic distances between the search terms: that is, when the number of pages indexed by Google goes to infinity, the NGD's must stabilize and converge to definite limit values.

By calculating the NGD's, networks of semantic distances between words can be generated, with which a computer can internalize the meaning of these words by their semantic interrelations. In several tests, we demonstrated that the method can distinguish between colors and numbers, between prime numbers and composite numbers, and can distinguish between 17th century Dutch painters. It also can understand the distinction between electrical terms and nonelectrical terms, and perform similar feats for religious terms, and emergency incidents terms. Furthermore, we conducted a massive experiment in understanding 100 randomly selected WordNet categories. There, we obtained an 87.5 percent mean agreement in accuracy of classifying unknown terms with the PhD-expert-entered semantic knowledge in the WordNet database. The method also exhibited the ability to do a simple automatic English-Spanish translation.

This research has been supported partly by the Netherlands ICES-KIS-3 program BRICKS, by NWO, the EU and ESF.

Links:
http://www.arxiv.org/abs/cs.CL/0412098

http://homepages.cwi.nl/~paulv/

http://homepages.cwi.nl/~cilibrar/

http://www.newscientist.com/channel/info-tech/mg18524846.100

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Reconstruction, Modelling and Motion Analysis of the Human Knee Based on Magnetic Resonance Images

by Gábor Renner and György Szántó

New computer methods and programs have been developed at SZTAKI in cooperation with the Orthopaedic Department of the Semmelweis University and the CT/MR Laboratory of the International Medical Center, Budapest. They support the three-dimensional visualization, reconstruction and modelling of the tissues and organs of the human body. These methods were used in examining the morphology and movement of the knee.

The knee joint is a very delicate and frequently damaged component of the human motion system. A wide range of imaging techniques (MR, CT) is available to clinical practitioners investigating the injured parts. These methods offer invaluable support to the orthopaedic surgeon by making visible both the state of the articular cartilage and certain joint diseases. The same tools can be applied to the analysis of kinematic behaviour as well as the morphology of the articular cartilage. When analysing articular motion, the determination of the contact points (regions) of the cartilage surfaces in three-dimensional (3D) space is especially important. Delineation of the contacting surfaces is extremely difficult due firstly to the similar grey-scale representation of the synovial fluid between the opposite surfaces and the hyalin, and secondly to the fact that the two surfaces are partly covering each other. We have developed computer methods for the image analysis, the 3D reconstruction, and for building geometric models of the knee joint based on MR/CT images. An iso-surface ray-tracing method with a Phong illumination model is used to create surfaces from volume grid models according to a predefined value of grey-scale threshold.

Surface points extracted from the iso-surface models represent only rough information on the shape. Accurate geometrical models are required for a detailed analysis of the shape and func-

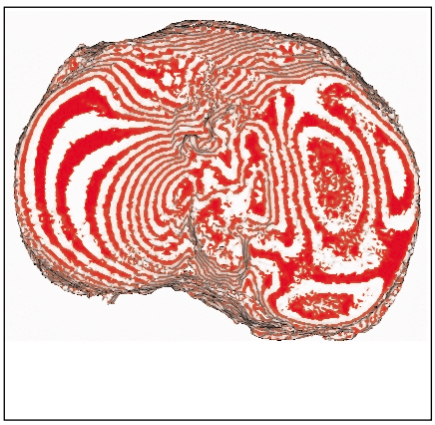

Figure 1: Plane intersections perpendicular to the tibia axis.

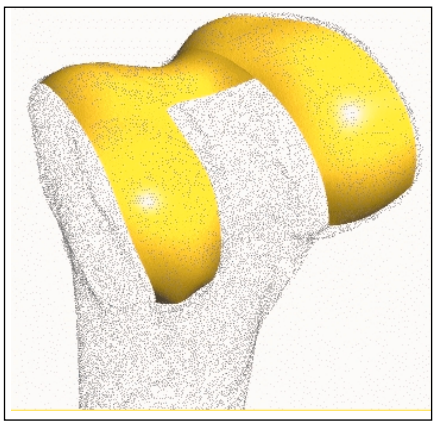

Figure 2: Active surface of the femur fitted to the point set.

tionality of the knee structures, especially when studying the contact properties of proximal or touching cartilage surfaces.

Spatial geometrical models are created using a set of contours extracted from MR images. We have developed active contour and fast marching methods for the detection of tissue contours in the sequence of MR images relevant to the knee joint (bone, cartilage). Our algorithms and programs based on these two methods work fast and reliably for bone contours; however, they require several improvements for cartilage contours.

By using contours extracted from 2D images and suitable transformations, a digitized representation (point set) of functional surfaces of the knee joint can be constructed. We have developed several methods and programs, which allow us to visualize and evaluate the morphology of those surfaces (eg noise elimination, decimation and triangulation). Various geometrical properties (eg lines of intersection, curvature distributions and feature points) can be calculated, visualized and evaluated.

The study of the knee in motion is important both from anatomical and pathological points of view. This requires the alignment of images and spatial models corresponding to different flexions of the knee in a common coordinate system (registration). Different types of registration methods (such as iterative closest point methods and methods based on anatomical markers or feature points) have been developed for the accurate and fast registration of knee structures.

Our experiments show that continuous and smooth representations of the active surfaces are needed for detailed biological or medical investigations (especially for estimating the size and shape of the contacting regions of cartilages).

Continuous surface fit starts with the topological ordering of points, which is done by creating a triangulation over the surface points. A good triangulation must meet a number of requirements: it must be topologically correct, must eliminate outlier points, triangles must have comparable side lengths and angles, their size must reflect the curvatures of the surface, and so forth. Algorithms and computer programs have been developed for the automatic generation of triangular structures. The mathematical description of surfaces with a high degree of continuity is performed by parametric surfaces commonly used in computer graphics and CAD (eg Bézier, B-spline and NURBS surfaces). The mathematical representation of continuous surfaces is computed by minimizing a functional. This contains the squared distances of data points to the continuous surface, as well as geometrical quantities reflecting continuity and smoothness.

Contact properties of cartilage surfaces (their shape and extension) can be best evaluated by a distance function defined between the two surfaces. This is the length of the shortest path from a surface point to the other surface. We have developed a procedure to evaluate the distance function for the continuous surface models of the cartilage. Surfaces can be colour-coded according to the distance function, which provides an extremely efficient tool for evaluating the shape and size of the contact regions. Figure 3 shows the colour-coded distances for the two contacting cartilage surfaces (femur and tibia).

The above methods provide the basis for a prototype system to be used in the surgical treatment of orthopaedic patients. The complex nature of the problems in this area means that close cooperation is required within a multidisciplinary team. The project, which has run from 2002-2005, has been greatly supported by the National Research and Development Programme of the Ministry of Education of Hungary.

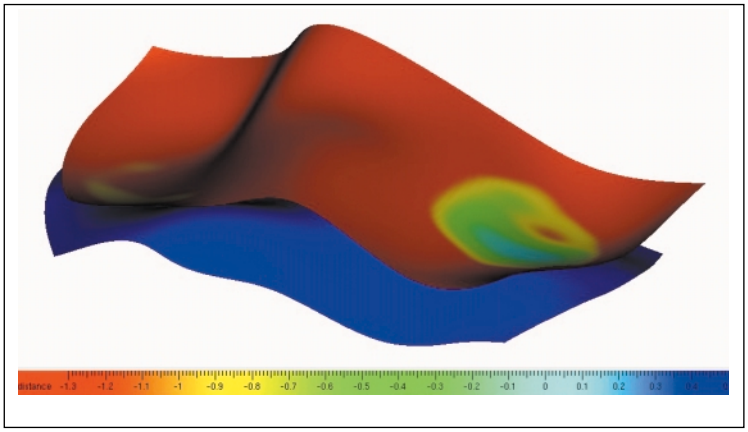

Figure 3: Color coded distance function of cartilage surfaces.

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Computer Controlled Cognitive Diagnostics and Rehabilitation Method for Stroke Patients

by Cecília Sik Lányi, Julianna Szabó, Attila Páll, Ilona Pataky

The HELEN (HELp Neuropsychology) computer-controlled diagnosis and therapeutic system was developed at the Colour and Multimedia Laboratory at the University of Veszprém, Hungary during the period 2002-2004. It was prepared to support the diagnosis and therapy of stroke patients, to keep records of the rehabilitation process and to help the therapeutic process. The system has been successfully tested at the National Centre of Brain Vein Diseases.

The system we have developed provides help for neuropsychological clinicians by supporting them in setting up the anamnesis, providing tests and training material for rehabilitation work and keeping track of patients' progress.

The system contains a form for holding patients' personal data, numerous tests and tutorial tasks, and a database in which the rehabilitation process is archived. The single tasks contain decision-making situations, and the system provides assistance in these cases if the patient seeks it. In case of failure the system provides the possibility of a new trial. The method used by the patient to solve the problems is stored, as this represents important information for the neurologist. To enable the patient to find his or her best solution to the problem, we have developed interactive procedures that permit the solution to be reached using different cognitive approaches. It was important that the different routes taken by patients should not influence the test results, which are expressed in points, but should guide the rehabilitation process.

During the diagnostic phase of the rehabilitation, the program keeps track of the patient's problem-solving strategy and uses this in selecting the best rehabilitation plan. In order to do this, we use syndrome analysis, meaning our system is not merely a collection of computerized tests, but has been built in such a way that it uses the solution provided by the patient to select the next task. The system contains tasks that relate to perception, memory and attention, including writing, reading and counting tasks. Further on, a new aspect in our solution is that through modern technical support one can change the difficulty of the task by using colouring, changing the local or global stroke intensity, or adding noise.The program also numerically presents the efficiency of the task solution. This means that diagnostic and therapeutic programs are not only used according to the individual needs, but also supply exact results and comparative data. One can therefore investigate cognitive and behaviour deficits in such a way as to activate the intact functions of the brain, thereby allowing the patient to control the course of the procedures. The pace of the rehabilitation is thus influenced by the cooperation of the patient, and by this involvement one hopes that the rehabilitation speed will also increase. In addition, the main menu of the HELEN program is constructed in order to allow new tests and practicing tasks to be added at any time.

Tasks to be used via the Internet	Therapeutic tests	Therapeutic tests
How many pictures do you see?	Picture with noisy background	Ordering of sentences
How many black and white checked drawings do you see?	Stories similar to the Binet pictures	Logical cards
How many cubes do you see?	Ordering according to form and colour	Clock
Where?	Recognition of emotions	Blind map
Memory game	Identify!	Story
Concealed pictures	Ordering of pictures	
Puzzle game	Recognition of faces	

Table: Tasks of the HELEN interactive and therapeutic test and teaching software.

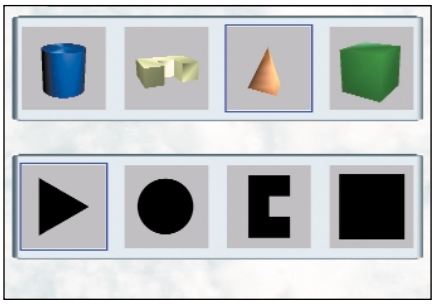

Figure 1: The "Where?" tasks.

Figure 2: How many pictures do you see?

The Specification of the Logical Structure of the HELEN Software

The following data are stored in the database of the software:

- personal data
- left- or right-handedness (this has to be known for the best strategy of certain tasks)
- data from the investigation, eg test results stored in the different submenus of the program, their solution strategy, drawings prepared by the patient, audio recordings etc.

The tasks of the HELEN interactive and therapeutic test and teaching software are shown in the table.

Steps of the Solutions of the Applied Research

The HELEN system contains several interactive computer-controlled rehabilitation programs. Using these programs the neurologist can reveal individual changes in the mental capacity of the patient, and can get new information on the cognitive functioning of the patient's brain. The program can be used also in group therapies.

The information stored in the database helps the neurologist to follow the individual rehabilitation path of the patient. It can also provide data on the typical behaviour of the patient, how he or she recognizes something, and give further insight into the sequencing of perception.

In the future we intend to supplement the system with further sub-tasks, so as to increase the variety of tests the neurologist can use. Based on user feedback, we intend to include stories that are more interesting and understandable for the stroke patients, so that they become more interested and involved in the rehabilitation process.

The rapid progress in the image-processing capabilities of modern computers enables the use of more sophisticated pictures, the introduction of animation, the use of virtual reality worlds etc. We are of the opinion that patients would appreciate more realistic presentations, stimulating them to become more involved and thus engage their mental capacity. All this could lead to quicker and more complete rehabilitations. Naturally this is at the present moment still only speculation; nevertheless, we feel it to be worth exploring, since it could help a non-negligible percentage of the now still inactive population to re-integrate themselves into normal life.

The development of the system was supported by the National Research and Development Fund, Hungary, Grant no. NKFP 2/052/2001

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NeuRadIR: A Web-Based NeuroRadiological Information Retrieval System

by Sándor Dominich, Júlia Góth and Tamás Kiezer

The Cost-Effective Health Preservation Consortium Project was formed to develop novel, Web-based Computer Tomograph (CT) image retrieval techniques for use in medical practice, research and teaching. The project was carried out in the Department of Computer Science, Faculty of Information Technology, University of Veszprém, within the Center of Information Retrieval between 2001 and 2004. It was sponsored by the National Research and Development Fund of the Széchenyi Plan, Hungary.

Medical images, like CT images, are increasingly important in healthcare, therapy treatment and medical research. The research results consist in applying information retrieval methods to human brain CT images and reporting retrieval. This represents a solution to the problem radiologists have of finding cases that match exactly or partially or are similar to the information they need, depending on the user's viewpoint. To satisfy these different requirements, three different information retrieval techniques were adopted in one system. The first is employed when the user requires cases that exactly match their information need. A Boolean retrieval technique using AND queries was used for this purpose. When the user wants to retrieve partially matching cases, the retrieval is performed by the Hyperbolic Information Retrieval (HIR) algorithm. Lastly, in order to find similar cases the Interaction Information Retrieval (I2R) method was implemented.

The advantage of using all three strategies is that they complement each other: the Boolean search retrieves every case exactly matching the query, the hyperbolic search retrieves every case having a partial match to the query, while the interaction search returns the most closely associated cases based on the query. The last two techniques were developed in the Center of Information Retrieval (CIR).

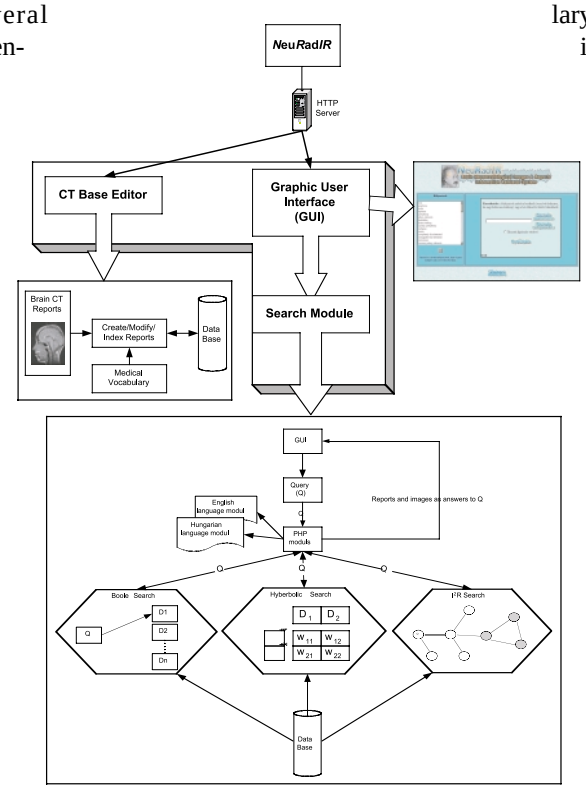
In medical practice, most image retrieval systems are designed to help experienced physicians with diagnostic tasks, and they require that users have prior knowledge of the field. This means they are not suitable for educational purposes. The results of our research from the application viewpoint will enhance the quality of both specialist consultation and medical education. General practitioners may confirm a diagnosis or explore possible treatment plans by consulting the CT retrieval system over the Web. Medical students may want to relate images with diagnoses, or to see images corresponding to different pathological cases such as lesion, bleed or stroke. Our system enables users (both radiologists and general practitioners) to make use of medical text and image databases over the Web, both in order to facilitate health preservation and to assist diagnosis and patient care. An assessment by radiologists found the application to be both relevant and effective.

System Description

The NeuRadIR (NeuroRadiological Information Retrieval System) applica-

tion (see Figure) consists of computer program modules written in several languages, as well as related documentation. Communication between the Web server and the search program is based on the CGI protocol. The CT Base Editor makes it possible to create and modify the database containing the images, corresponding reports and index files. The Search Module is used on-line on the Web, and consists of user interfaces and search programs. The query is formally analysed and interconnected with the database. A controlled vocabulary was created based on both textual reports and standard specialist queries.

The title page of the 'Search Screen' contains a header at the top, whilst the area underneath is divided into two halves: the left half contains the terms of the controlled vocabulary, whilst the right half contains the search buttons and the query. Medical terms can be selected from the vocabulary or freely entered from the keyboard in the query line. The user selects one of the searching strategies by clicking on the appropriate button. This returns a hit list, and by clicking on any hit both textual information and CT images are displayed.



System diagram and architecture of NeuRadIR application.

The NeuRadIR system has been demonstrated on several national and international forums and can be accessed from the project homepage. In the future, we plan to extend the application by making use of feature extraction modules to index images.

Link:
http://www.dcs.vein.hu/CIR/neuradir/app/

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ARGO: A System for Accessible Navigation in the World Wide Web

by Stavroula Ntoa and Constantine Stephanidis

ARGO is a system for accessible navigation in the World Wide Web, which addresses the requirements of diverse target user groups, including people with disabilities. ARGO supports visual and non-visual interaction in order to satisfy the requirements of blind users, users with vision problems, and users with mobility impairments of the upper limbs. ARGO has been developed by ICS-FORTH in the context of the EQUAL PROKLISI Project.

In the context of the 'Community Initiative EQUAL' of the European Commission, the Project PROKLISI – 'Identifying and combating simple and multiple discrimination faced by people with disabilities in the labour market', coordinated by the Hellenic National Confederation of People with Disabilities, aims to identify and combat the difficulties that people with disabilities and their families face in accessing and remaining in the labour market. One of the goals of the PROKLISI project is to exploit the potential that new technologies provide in order to develop innovative systems and tools aimed at ensuring access to information and communication to groups that are usually discriminated in the employment market.

Under this perspective, a system for accessible navigation in the World Wide Web has been developed, called ARGO, which addresses the requirements of diverse target user groups, including people with disabilities. The system supports visual and non-visual interaction in order to satisfy the requirements of:

- blind users and users with vision problems
- users with mobility impairments of upper limbs.

The ARGO system operates on Microsoft Windows XP, supports all typical functionalities of a browser application, and additionally includes:

- innovative mechanisms for the representation of links and the structure of web pages
- innovative mechanisms for accelerating user interaction with the system
- facilities for finding words and phrases in web pages
- speech synthesis software support

- compatibility with alternative interaction devices
- high-level security provision for networking functionalities
- HTML 4.0 support.

In order to address the needs of the various target user groups, ARGO employs different operation modes (visual and non-visual interaction), as well as alternative input and output devices.

Overview of the ARGO system.

The system operates in three different modes:

- non-visual mode, appropriate for blind and users with severe vision impairments
- visual mode enhanced with scanning technique, appropriate for users with severe motor impairments of the upper limbs
- visual mode without assistive interaction techniques or input and output devices, appropriate for able-bodied users.

In non-visual interaction, user input is provided through the keyboard, while the system output is provided through the use of synthetic speech and, when necessary, warning sounds. All visual interface elements are organised in a non-visual hierarchical tree structure. By using the appropriate keyboard input commands, the user can navigate in the hierarchy and interact with the currently active interface element.

In visual interaction with scanning, the user provides input through three switches and receives the system output through the screen. All the interactive interface elements of the application are automatically scanned (highlighted), providing the user with the opportunity to interact with each one of them. Thus, there is only one active interface element for each dialogue step, indicated by a coloured border that highlights it. The user may interact with the indicated element, or move the scanning dialogue to the next interactive interface element, by pressing the appropriate switch.

Users with less severe impairments, such as low vision or limited dexterity, can also be assisted by the system, by using the simple visual interface of ARGO in combination with the accessibility features of the operating system (eg, magnifier, mouse keys, sticky keys, etc).

Evaluations with usability experts and users that took place in the usability laboratory of ICS-FORTH indicated that the system is usable and can be useful to people with disability.

According to the project requirements, the ARGO system has been designed in order to operate as an information point in public places. Therefore, specifications have been provided regarding the setting of the information system and the arrangement of the assistive devices for full accessibility. To facilitate blind users in locating the system and learning how to use it without any assistance, a camera is attached to the system, and when motion is detected, instructions of use are announced.

The ARGO system is currently installed and in use in two information kiosks in the municipalities of Cholargos (Attiki district) and Neapoli (Thessaloniki district).

Future work includes evaluating ARGO with real users in the municipalities where it is currently available, and improving the system according to the evaluation results.

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BRICKS: A Digital Library Management System for Cultural Heritage

by Carlo Meghini and Thomas Risse

The aim of the BRICKS project is to design and develop an open, user- and service-oriented infrastructure to share knowledge and resources in the Cultural Heritage domain. BRICKS will provide cultural heritage institutions and users the possibility to share their content and services with other users.

BRICKS (Building Resources for Integrated Cultural Knowledge Services) is an Integrated Project of the 6th Framework Programme (IST 507457) within the research and technological development programme 'Integrating and Strengthening the European Research Area (2002-2006)'. BRICKS began in January 2004 and has a duration of 42 months. The BRICKS Consortium consists of 24 partners; 7 from academia, and the rest equally distributed between users and industry, mostly SMEs. The target audience is very broad and heterogeneous and involves cultural heritage and educational institutions, the research community, industry, and citizens. The project

is coordinated by Engineering SpA, Italy.

Requirements

The BRICKS infrastructure will use the Internet as a backbone and has been designed to enable:

- Expandability, which means the ability to acquire new services, new content, or new users, without any interruption of service
- Graduality of Engagement, which means offering a wide spectrum of solutions to the content and service providers that want to become members of BRICKS
- Scalability
- Availability
- Interoperability.

In addition, the user community requires that an institution can become a member of a BRICKS installation with minimal investments, and that the maintenance costs of the infrastructure, and in consequence the running costs of members are minimal. BRICKS membership will also be flexible; parties can join or leave the system at any point in time without administrative overheads.

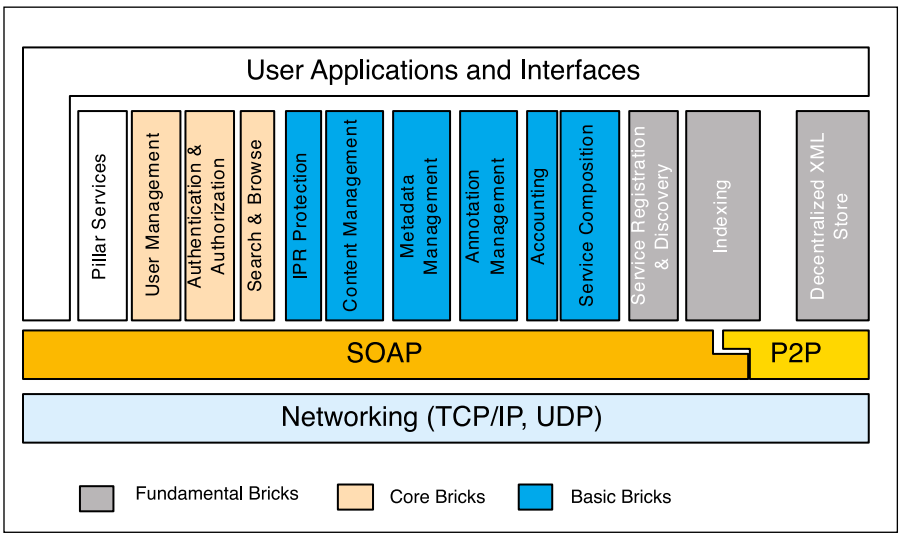
Approach

It has been decided that the BRICKS architecture will be decentralised, based on a peer-to-peer (P2P) paradigm, ie no central server will be employed. Every member institution of a BRICKS installation is a node (a BNode in the BRICKS jargon) of the distributed architecture. BNodes use available resources for content and metadata management. A single BNode only has direct knowledge of a subset of other BNodes in the system. However, if a BNode wants to reach a member with which it is not in direct communication, it will forward a request to some of its known neighbour BNodes; these will deliver the request to the final destination or forward again to other nodes.

The Bricks of BRICKS

The figure shows the architecture of a BNode. The components (bricks, in the BRICKS jargon) making up the architecture are Web Services, and are divided into 3 broad categories:

- Fundamental bricks; these are required on a BNode for its proper functioning and to maintain membership in the community. In addition to the P2P layer, other fundamental services are: Decentralised XML Storage (providing data ubiquity on the P2P architecture), Service Registration and Discovery, and Index management
- Core bricks; these are needed if a local BNode installation wants to provide its local users with access to BRICKS. They include: User Management, Authentication and Authorisation, and Search and Browse
- Basic bricks: these are optional, and are deployed on the BNode only if needed (ie the Content Management brick will be deployed only if the institution running the BNode exposes content to the BRICKS installation). They include: Content Management, Metadata Management, Accounting, IPR Protection, Annotation Management, and Service Composition.



Architecture of a BNode.

Pilot Applications

In order to render BRICKS operational in the Cultural Heritage domain, the project will develop 4 applications (Pillars, in the BRICKS jargon):

- Archaeological Site, which includes four scenarios: Cultural Landscape Discoverer (sharing knowledge about cultural landscapes), Finds Identifier (identification of objects brought to a museum by members of the public), Landscapes Reconstructed (reconstruction of knowledge about cultural landscapes), and Pompeii and Roma (access to visual artefacts)
- The European Museum Forum, which aims at introducing a digital application process for the European Museum of the Year Award
- Living Memory, which aims at developing a collaborative environment targeted at the general public, and allowing the creation of cultural contents and their sharing among the rest of the community
- Scriptorium, which will facilitate the work of historians and archive professionals, universities, cultural research centres, libraries, history professors and teachers, and others, through the definition of a new way to exploit and manage Distributed Digital Texts and historical documents. The specific scenario will be the creation of a critical edition of an ancient manuscript.

Link:
BRICKS Community:
http://www.brickscommunity.org/

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Student Programming Project becomes Multi-Million Dollar Company

by Nancy Bazilchuk

Everyone likes a sure bet. But two computer scientists who have their Master,s degrees from the Norwegian University of Science and Technology have found a way to turn bookmaker's odds into money in their pocket with a clever information-gathering program.

In March 2005, the two graduates — now entrepreneurs — moved their rapidly growing business, Norwegian Market Monitor AS, to new headquarters in Trondheim, Norway.

The program developed by Petter Fornass and Tore Steinkjer, who studied for their Master's degrees together at NTNU, uses a high accuracy wrapper to crawl the Internet and collect information about the odds that have been set for 25 different sports across the globe. About 300 sites are regularly checked for information. This technology has become Betradar.com, which monitors odds and is updated every few minutes.

Petter Fornass, co-founder of Norwegian Market Monitor AS.

"Since we are collecting numbers, everything has to be 100 percent correct," Fornass says. More than 100 bookmakers around the globe now use this web-crawling technology. Because even small differences in odds can result in huge losses for bookmakers, bookmakers can use Betradar.com to check to make sure the odds they have set for various sporting events are in line with odds set elsewhere on the planet.

Petter Fornass is now CEO of Norwegian Market Monitor AS, which owns and operates Betradar.com. His interest in developing an information collection technology began with a simple desire to finance expenses associated with his master's degree in computer science at NTNU. He developed a web-crawling program with Steinkjer that allowed them to check and compare hundreds of websites for betting odds. The program enabled the pair to find differences in odds for the same sporting event. With this information, they could then place sure bets that guaranteed a win.

But as Fornass and Steinkjer discovered, placing bets and playing the odds can be cash-intensive, even if you are always guaranteed a win.

They were also far more interested in the programming challenges of their project rather than the financial benefit in and of itself.

Fornass and Steinkjer launched their company from their offices at the Gløshaugen campus of NTNU in 2000. The launch was a little more unusual than most: instead of participating in the Venture Cup competition in Norway, the business plan competition that helps Scandinavian students, researchers and others to take their business idea from concept to actual start-up, Fornass and Steinjker decided to look for venture capital on their own - and found it. In late March 2005, the pair moved their rapidly growing business out of the Innovasjonssenter Gløshaugen to new offices on the Trondheim waterfront. Among the products developed by the group is Sports Fixtures, which reports starting times and dates for hockey, soccer and tennis matches and other sports, with daily updates on more than 10 sports one week in advance. Results are delivered 2-3 times per day.

Another key service is called Odds Radar, which detects the odds and starting times from more than 140 bookmakers. Bookmakers can view 8000 odds and 2000 starting times of their competitors each day, and are provided a comprehensive monitoring service of more than 200 Internet sources for odds each day. The monitoring module shows the odds key that was used in setting odds and the odds history and date changes for each bookmaker detected as a part of the program. The service allows bookmakers to compare their odds and starting times with the market average, with alerts of critical differences by e-mail or SMS. The program also detects incorrect results, errors from typos or matches that have been missed or left out, and presents the official schedules from federations or tournament organizers if available on the Internet.

The company employs 27 people, with 10 employees in Norway, 13 employees in Germany, three in Switzerland and one in Czechoslovakia, and more than 100 clients spread across the globe.

Link:
http://www.betradar.com

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Software Engineering Institute goes International in Software Process Research

by Mario Fusani

In industrial prototyping and production, the shifting of the object of study from product to process is more than a century old and has been at the basis of significant product improvement. In software technology, a similar effort has been attempted for a couple of decades, both with empirical software engineering approaches and with mathematical models, yet the results in software-dependent products and services are not as bright as could have been expected.

On the empirical side, corporate and public standards for software development have flourished in recent years. It has been shown that standards impact directly on industry (even the software industry) much more than solutions proposed in specialised literature. For this very reason, standards should embody applicable results of scientific research, whereas frequently they do not. A consequence is that, despite an increasing tendency of developers to follow recognised international norms, there is growing concern about the ability of empirical software development processes to respond to the emerging needs of the global information society. On the formal methods side, indicative is the fact that the application of mathematical models (together with the instruments that can be derived) by software process managers is still a somewhat rare occurrence. So the big questions are:

- what will be the successful paradigm(s) for the software process in the near future?
- what requirements must the software satisfy?
- how will these requirements be influenced by other (social, political, economical, geographical) factors?

At the Software Engineering Institute (SEI), this concern has been taken on-board as an exciting challenge (the bigger the problem, the happier the researcher, one could say). 'Exploring What's Next in Software Process Research' has been the leading concept of a recent initiative, sponsored by SEI and by several private corporations and has led to the constitution, in August 2004, of the International Process Research Consortium (IPRC), a world-wide association of researchers. Six European countries are joining SEI in this effort, Italy being represented by a researcher from ISTI-CNR.

The main goal of IPRC is to prepare a Roadmap for software process research for the next 5-10 years. The aim will be to provide indications on how the technology challenges of the near future should be addressed by the software industry. However, software is not the only issue of interest for IPRC researchers. Here below we summarise the main activities:

- a number of working groups have been set-up to investigate distinct areas of interest
- six workshops will be held between August 2004 to August 2006 in which ideas of the IPRC member researchers will be proposed and debated; working groups will continue their activity in the meantime
- different nationalities, cultures and needs are represented in the research teams, to avoid localisation and privileged solutions
- experts in non-technical disciplines, such as economy, psychology and organizational science, are invited to lecture to the technical team
- experts (from SEI) in working group behaviour act as facilitators, catalysing reactions among researchers
- various interaction mechanisms are activated by the facilitators to obtain maximum benefit from the collaboration;

and the current IPRC approaches and contents:

- technical and non-technical discussion has been solicited from the members in an unbiased way, allowing considerable divergence of points of view and perspectives; convergence is expected as ideas and activity mature around elements of the roadmap
- widely-disparate content has been deployed so far in the form of statements in order to establish relationships and priorities: needs, hot/warm/cold research topics, state-of-art and trends in software process solutions, human factors, known and mysterious forces pushing forward/retarding progress, and so on
- a scenario-based approach is being explored to analyse the impact of a future multi-dimensional 'trends space' in any of the software process elements; the lack-of-crystal-ball uncertainty is amended by considering each trend in two opposing directions; this implies much work if completeness is the goal, but knowledge can be increased, even with partial analyses.

The outcomes of the two workshops held so far are considered very promising, thanks to the huge amount of material examined and the ideas generated by the discussions. Although much work is needed before there can be convergence towards concrete proposals, we already have the impression that, in addition to the Roadmap, other results and new lines of research will emerge from the work of the Consortium.

Links:
http://www.sei.cmu.edu
http://www.sei.cmu.edu/iprc/

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Bioinformatics Experts converge on Dublin City University for One-Day Workshop and Symposium

by Ray Walshe

The School of Computing at Dublin City University hosted BIONFORMATICS INFORM 2005, a one-day international workshop and symposium that brought together industry, academia and venture capitalists to highlight the importance of this sector for the Irish economy on Wednesday, 17 February 2005. The event also served to facilitate dissemination of information across these groups and to showcase the current state of Bioinformatics research in Ireland today.

The event was officially opened by Mr Noel Aherne, T.D., Minister for Housing and Urban Renewal. He welcomed the 300 delegates to the Helix, stating that, "this conference provides an ideal opportunity in this area for partnering and knowledge sharing. It can play a key role in encouraging that collaboration and I wish the event organisers every success not only with this conference but also with their efforts into the future".

Left to right: Ray Walshe, Director of Bioinformatics, DCU; Mr. Noel Aherne TD, Minister for Housing and Urban Renewal and Albert Pratt, Deputy President of Dublin City University.

Among the guest speakers were Dr. Ena Prosser, Director of Enterprise Ireland Biotechnology Directorate; Prof. Denis Headon, President of Biolink USA-Ireland; Dr. Anton Enright, Computational and Functional Genomics, Sanger Institute; Seamus O' Hara, Director of Seroba BioVentures; and Dr. Jim Ryan, Associate Director of Circa Group Europe. Prof. Michael Comer, Director of Research at the Adelaide and Meath Hospital and Chair of the morning session, remarked that DCU was an appropriate setting for the event as it was the first university in Ireland to graduate taught Master students in Bioinformatics. He also commented on the success of the programme and the quality of graduates it had produced.

BIONFORMATICS INFORM 2005 has been a tremendous success and the organisers are very grateful for the positive feedback received from government agencies and industrial partners, especially the sponsors. They are particularly thankful to the staff from Dell, IBM, Enterprise Ireland, IDA Ireland, Global Pharma Networks, Icon Clinical Research Labs, and the Irish Medical Devices Association, whose participation and involvement contributed to the success of this international event. It was extremely encouraging to see representation from all of the Irish universities, many of the Institutes of Technology, and lots of our colleagues who travelled from many of the institutions in Northern Ireland. The large number of industry delegates present also led to very exciting networking sessions around the event. We anticipate that BIONFORMATICS INFORM will become an annual event highlighting progress in this important sector for the Irish economy.

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CALL FOR PAPERS

ILCP 2005 — The 21st International Conference on Logic Programming

Sitges (Barcelona) Spain, 2-5 October 2005

Since the first conference held in Marseilles in 1982, ICLP has been the premier international conference for presenting research in logic programming. Contributions (papers and posters) are sought in all areas of logic programming including but not restricted to theory, environments, language issues, implementation, alternative paradigms and applications.

Specific attention will be given to work providing novel integrations of these different areas, and to new applications of logic programming. Contributions on applications will be assessed with an emphasis on their impact and synergy with other areas, as opposed to technical maturity. Applications of logic programming to the Semantic Web are especially encouraged.

The technical program will include several invited talks and advanced tutorials, in addition to the presentations of the accepted papers and posters. A special session on industrial applications of logic programming is also planned and several workshops will be held in parallel with the conference. For the first time, a doctoral student consortium will be organized as part of ICLP. This consortium will allow participants to interact with established researchers and with other students, through presentations, question-answer sessions, panel discussions, and invited presentations.

Important Dates

- Abstract submission deadline: 30 April 2005
- Submission deadline: 6 May 2005
- Notification to authors: 24 June 2005
- Camera-ready copy due: 15 July 2005
- Early registration deadline: 29 July 2005

.

More information:
http://www.iiia.csic.es/iclp2005/

CALL FOR PAPERS

CP 2005 — The 11th International Conference on Principles and Practice of Constraint Programming

Sitges (Barcelona) Spain, 1-5 October 2005

The CP conference is the annual international conference on constraint programming, and it is concerned with all aspects of computing with constraints, including: algorithms, applications, environments, languages, models and systems. CP 2005 includes a technical programme, where presentations of theoretical and application papers, as well as invited talks and tutorials, aim at describing the best results and techniques in the state-of-the-art of constraint programming. Moreover, CP 2005 continues the tradition of the CP doctoral programme, in which PhD students can present their work, listen to tutorials on career and ethical issues, and discuss their work with senior researchers via a mentoring scheme. Finally, there will also be a number of workshops, where researchers will be able to meet in an informal setting and discuss their most recent ideas with their peers.

Papers are solicited from any of the disciplines concerned with constraints and any of the domains using constraints. Topics include problem modelling, problem solving, efficiency and usability. Papers which report on successful applications of constraint technology are also solicited.

Important Dates

- Deadline for submissions: 6 May 2005
- Notification to authors: 24 June 2005
- Camera-ready copy due: 15 July 2005
- Early registration deadline: 29 July 2005.

More information:
http://www.iiia.csic.es/cp2005/

Report on the Impact Assessment of the IST-FET Open Scheme

The Future and Emerging Technologies (FET) activity of the EU's IST-FP6 Programme has recently undertaken an exercise to assess the scientific and technological impact of its FET-OPEN scheme. This impact assessment is based on the achievements of projects that FET funded in the period 1994-2004. The report with the main findings is now available.

The different EU Framework Programmes for RTD have had a strong tradition of support for collaborative technology research of a basic and longer-term nature in the area of Information and Communication Technologies (ICTs).

Dating back as far as 1989, with the advent of the 2nd Framework Programme (FP2), came the consensus that supporting basic research in ICTs is a solid investment the payback of which, even if it does not come in the form of short-term industrial applications, is and will be significant. In FP3 and FP4, the follow-up actions on basic technology research aimed to lay the foundations for 'next wave' ICT technologies that would underpin the future developments of European R&D. In addition to research, these actions also focused on community building and on developing knowledge, skills and infrastructure and were designed to be open both in terms of research agendas and communities addressed. Many of the activities launched under these actions, known today as the FET-OPEN scheme, have since passed into the 'mainstream' RTD under the subsequent framework programmes.

Recently, the Future and Emerging Technologies (FET) activity of the EU IST-FP6 Programme has undertaken a broad exercise to assess the scientific and technological impact of the FET-OPEN scheme. This impact assessment is mainly based on the achievements of projects funded in the period 1994-2004 (ie, FP4, FP5 and FP6 projects). According to the report findings, the FET-OPEN scheme proved to be particularly successful in opening new S&T possibilities, setting the agenda for future ICT research programmes, providing/exploring alternative technology solutions for industry, and confirming the path-finding role that FET has in IST.

It is the ambition of the IST-FET team to continue the FET-OPEN scheme in the coming FP7, thus retaining the core values which have characterised its success to date and continuing to support visionary, high-risk, high return long term multidisciplinary collaborative research.

Links:
The FET-OPEN Impact Assessment Report can be downloaded from:
http://www.cordis.lu/ist/fet/press.htm

FET-OPEN scheme:
http://www.cordis.lu/ist/fet/home.htm

Please contact:
Gustav Kalbe, FET-OPEN co-ordinator
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Orbit-iEX in Basel

Orbit-iEX is a new conference / exhibition, growing out of the merger of the former Orbit and InternetExpo conferences. Orbit-iEX will be held at the Messe Basel complex in Basel, Switzerland from 24 – 27 May, 2005. As to the exhibition, over 400 businesses have registered at this writing. The topics covered by the accompanying conference of some 80 seminars include talks on Software and Processes, Communications and the Internet, and IT Systems and Appliances. The seminars will be held in German.

More information:
http://www.orbit-iex.ch

CALL FOR PAPERS

ERCIM Working Group on Formal Methods for Industrial Critical Systems

FMICS 05 — 10th International Workshop on Formal Methods for Industrial Critical Systems

Lisbon, Portugal, 5-6 September 2005

The aim of the FMICS workshops, which are celebrating their tenth occurrence this year, is to provide a forum for researchers who are interested in the development and application of formal methods in industry. In particular, these workshops are intended to bring together scientists who are active in the area of formal methods and interested in exchanging their experiences in the industrial usage of these methods. These workshops also strive to promote research and development for the improvement of formal methods and tools for industrial applications. Topics include, but are not restricted to:

- tools for the design and development of formal descriptions
- verification and validation of complex, distributed, real-time systems and embedded systems
- verification and validation methods that aim at circumventing shortcomings of existing methods with respect to their industrial applicability
- formal methods based conformance, interoperability and performance testing
- case studies and project reports on formal methods related projects with industrial participation (eg safety critical systems, mobile systems, object-based distributed systems)
- application of formal methods in standardization and industrial forums.

The workshop is organised by ISTI-CNR, Italy and University of Goettingen, Germany.

Important Dates (indicative)

- Deadline for submission: 15 May 2005
- Accept/Reject notification: 15 June 2005
- Final manuscript: 7 July 2005

More information:
http://fmt.isti.cnr.it/FMICS05/
http://www.inrialpes.fr/vasy/fmics/

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POLICY 2005 — IEEE 6th International Workshop on Policies for Distributed Systems and Networks

Stockholm, Sweden, 6-8 June 2005

POLICY 2005 is the sixth in a successful series of workshops which, since 1999, has brought together leading researchers and industry experts to discuss problems, solutions and experiences in developing policy-based systems.

The workshop will include both refereed papers and invited presentations which will be published by IEEE Press. In line with past workshops, there will be substantial time allocated for discussions as well as panel sessions.

POLICY 2005 will be co-located with the Tenth ACM Symposium on Access Control Models and Technologies (SACMAT 2005).

Topics of interest include, but are not limited to:

Policy Definition and Models:

- abstractions and languages for policy specification processes
- methodologies, and tools for discovering, specifying, reasoning about, and refining policy
- extensions and refinements of policy standards
- relationships between policies, eg hierarchies

Policy Mechanisms:

- implementation and enforcement techniques
- integrating policies into existing systems and environments
- policy management in the large: peer-to-peer, grid and web-based services, utility environments
- interoperability

Policy Applications:

- policy models for access-control, resource allocation, systems management, QoS adaptation, intrusion detection and privacy
- policy based networking, including active networks, mobile systems and e-commerce
- business rules and organizational modelling
- trust models and trust management policies
- policies for pervasive computing
- case studies of applying policy-based technologies
- policy-based autonomic computing
- policy-based utility computing
- SLA/contract based Management
- policy based collaboration.

More information:
http://www.policy-workshop.org/

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ECDL 2005 — 9th European Conference on Research and Advanced Technology for Digital Libraries

Vienna, Austria, 18-23 September 2005

ECDL 2005 is the 9th conference in the series of European Digital Library conferences. ECDL has become the major European conference on digital libraries, and associated technical, practical, and social issues, bringing together researchers, developers, content providers and users in the field. ECDL 2005 is jointly organized by the Vienna University of Technology (VUT), the Austrian National Library (ÖNB), and the Austrian Computer Society (OCG).

Topics of interest include, but are not limited to:

- concepts of digital libraries and digital documents
- system architectures, integration and interoperability
- information organization, search and usage
- user studies and system evaluation
- digital preservation
- digital library applications.

More information:
http://www.ecdl2005.org/

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Tenth IFIP TC13 International Conference on Human-Computer Interaction

Rome, Italy, 12-16 September 2005

The INTERACT '05 conference will highlight to both the academic and industrial world the importance of the Human-Computer Interaction area and its most recent breakthroughs on current applications.

Suggested topics include but are not limited to:

- Multi-modal Interfaces
- Context-dependent Systems
- End User Development
- Intelligent Environments
- Tangible Interfaces
- Novel User Interfaces
- Usability Evaluation
- Location-aware Interaction
- Model-based Design of Interactive Systems
- Multi-user Interaction
- Safety Issues and Human error
- Cognitive Models
- Visualisation Techniques
- Web Design and Usability
- Mobile and Ubiquitous Computing
- 3D and Virtual Reality Interfaces
- Adaptive Interfaces
- Web Accessibility
- Usability & Accessibility.

INTERACT 2005 will feature three keynote speakers:

- Bill Buxton, Buxton Design, Innovative Interaction Techniques
- Flavia Sparacino, Sensing Places, Natural Interaction
- Steven Pemberton, CWI and W3C, The Future of Web Interfaces.

More information:
http://www.interact2005.org/

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In cooperation with the ERCIM Semantic Web Working Group

DISWeb'05 — International Workshop Data Integration and the Semantic Web

Porto, Portugal, 14 June 2005

The advent and the wide availability of the web have dramatically increased the need for efficient and flexible mechanisms to provide integrated views over multiple heterogeneous information sources. However, information on the web is placed independently by different organizations, thus documents containing related information may appear at different web sites and in different formats. Also, the research on information integration is facing new challenges raised by the changes to the economical and financial environment where database systems are used. For example, in-house data warehousing may be no longer sufficient to support an the information needs of an organization.

While there has been a significant focus on data integration during the last decade, there is a new vision that is brought by the Semantic Web, which aims at making data machine processable. To use this vision, the semantics of the data needs to be taken into account when performing integration.

The aim of this workshop is to provide a forum for the presentation of solutions to the challenges that are brought by the semantic integration of web information. In particular, research papers are sought that explore new approaches for the semantic annotation of web data and for the use and development of ontologies. DISWeb'05 continues the tradition of the previous three workshops in fostering the debate on new issues and directions in the integration of heterogeneous data, with special emphasis this year on semantic issues.

The workshop is held in Conjunction with CAiSE'05.

More information:
http://www.lirmm.fr/~bella/disweb05/

CALL FOR PARTICIPATION

CMMR 2005 "PLAY!" — 3rd International Symposium on Computer Music Modeling and Retrieval

Pisa, Italy, 26-28 September, 2005

CMMR is an annual event focusing on important aspects of computer music and CMMR 2005 is the third event in this series. CMMR 2004, jointly organized by Aalborg University Esbjerg in Esbjerg, Denmark and LMA, CNRS in Marseille, France, was held in Esbjerg, Denmark, on May 2004. The CMMR 2004 post symposium proceedings were published by Springer in the Lecture Notes in Computer Science Series (LNCS 3310).

The field of computer music is interdisciplinary by nature and closely related to a number of computer science and engineering areas such as information retrieval, programming, human computer interaction, digital libraries, hypermedia, artificial intelligence, acoustics, signal processing, etc. In this year's CMMR we will focus on the human interaction in music, simply the PLAY, meaning that papers related to sound modeling, real-time interaction, interactive music, perception and cognition are particularly welcome together with the usual themes related to the traditional topics of the CMMR conference.

CMMR 2005 "PLAY" thus invites researchers, educators, composers, performers, and others with an interest in important aspects of computer music (including modeling, retrieval, analysis, and synthesis) to come join us for a unique event.

The conference is co-organized by CNR-Pisa, Italy and LMA-CNRS Marseille, France, and will be held at the CNR Research Campus in Pisa, Italy.

The submission deadline for full and short papers is 1 May 2005.

More information:
http://www.interact2005.org/

ERCIM NEWS

ERCIM News is the magazine of ERCIM. Published quarterly, the newsletter reports on joint actions of the ERCIM partners, and aims to reflect the contribution made by ERCIM to the European Community in Information Technology. Through short articles and news items, it provides a forum for the exchange of information between the institutes and also with the wider scientific community. This issue has a circulation of 11,000 copies.

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EURO-LEGAL

News about legal information relating to Information Technology from European directives, and pan-European legal requirements and regulations.

Access to Information: the Right to Know and the Need to Manage

On 1 January 2005 the UK implemented new legislation to provide access to information held by all public authorities: the Freedom of Information Act 2000 and the Freedom of Information (Scotland) Act 2002. While many countries have put Freedom of Information law in place, the UK resisted attempts to introduce this type of legislation until 2000, and it has taken five years to implement in full. The legislation now in force allows any person, from any country, to request access to any information held by a UK public authority, subject to certain (admittedly, fairly broad) exemptions. The Act applies to information held in any format, and from any date. At the same time, the Environmental Information Regulations 2004 updated previous legislation in order to provide for public access to environmental information. The new legislation supplements existing laws governing privacy and access such as the Data Protection Act 1998 and the Medical Records Act 1990.

The impact of a Freedom of Information Act has been far-reaching, far beyond simply requiring an organisation to respond to requests. There is now a presumption that information must be made available unless there is a reason otherwise – the 'right to know'. There is an obligation to publish information to the public proactively, and in electronic format wherever possible, so a person does not have to make a formal request for routine information. Every organisation subject to the Act has to present a Publication Scheme, detailing what information it commits to make available, for approval to the Information Commissioner. The CCLRC has an electronic publication scheme at http://www.foi.cclrc.ac.uk, which provides the information online wherever possible, and also provides a form for submitting requests. In addition, in support of our commitment to open publishing, our corporate digital repository, the CCLRC e-Publications Archive at http://epubs.cclrc.ac.uk, has been developed to record and publish the scientific output of CCLRC.

Legislation granting access to information is, however, meaningless if the organisation cannot actually locate that information when requested. Every public authority in the UK has needed to address its records management process and assess the technologies used for recording, and retrieving, its information. The risk of needing to verify electronic information in court requires technologies that support the evidential weight of information held in electronic form. The organisational requirement to capture e-mails from individual mailboxes to the corporate memory store has been given additional impetus. Like many public authorities, the CCLRC has implemented an accredited Electronic Document and Records Management system in support of its records management programme, working together with the other UK Research Councils to promote best practice and sharing of information wherever possible.

And what of Freedom of Information requests received? This organisation receives requests for information all the time, which are part of everyday business and dealt with as such. So far at CCLRC we have logged only eight FOI requests, and the information requested has been provided in full, at no cost to the requester. Central and local government and other agencies have received many more, some of which have still been refused, but the Act has undoubtedly increased the provision of information.

The impact of the Freedom of Information Act cannot be measured simply in numbers of requests and what information has been released or withheld. The cost in money and effort in preparing for the new access regime has been significant, but the benefits are already evident from improved information management. The Act has promoted a growing awareness of the need not only to archive, but to actively curate information, and to implement the technological solutions to provide continuing access to information in the future.

by Judy Beck, CCLRC
Editor: Heather Weaver, CCLRC, UK

CNR — **Amedeo Cappelli**, ISTI-CNR, has been appointed scientific director of the Center for the Evaluation of Language and Communication Technologies (CELCT) in Trento, Italy. CELCT has been created as a joint initiative of DFKI (Center for Artificial Intelligence) Germany, ITC-irst (Center for Scientific and Technological Research) Italy and the Province of Trento. Representatives of the French and German Ministries for Research attended the inauguration ceremony held on 26 January this year. CELCT aims at supporting cooperation between private enterprises and the scientific community in order to promote research and technology innovation in the ICT field. The Centre will focus on developing evaluation procedures for Human Language Multimodal Communication Technologies (HL-MCTs), eg multilingual question answering, speech-to-speech translation, cross-language information retrieval, word sense disambiguation and multimodal technologies. CELCT will also publish evaluation guidelines and will provide services for companies operating in the HL-MCT field. See http://www.celct.it

SZTAKI — **András Siegler**, vice president of the National Office for Research and Technology, Hungary, former deputy director of SZTAKI and former member of the ERCIM Executive Committee of ERCIM representing SZTAKI, has been appointed to the position of the director responsible for the international scientific and technological co-operation at Directorate General Research, following the decision taken by the European Commission on 19 January 2005. András Siegler worked with SZTAKI from 1975 to 1996. At the European Commission he will be in charge of formulating and managing the scientific and technological co-operation policy of the EU with the third countries (countries which are not members of the Union) and with international organizations.

Irish Universities Consortium — **Information Quality Network (IQ Network) launched at Dublin City University**. The DCU School of Computing hosted the launch of the Information Quality Network (IQ Network) with the "Information Quality Breakfast Briefing" on Thursday, 24 February 2005. The IQ Network is a special interest group for professionals and researchers concerned about the quality of business data and information. The Breakfast Briefing, which was organised in conjunction with the International Association for Information and Data Quality (IAIDQ, www.iaidq.org), included informative talks from representatives of eircom, BT Exact, IBM, SAP, and the Assistant Data Protection Commissioner. Among the issues explored were evolving best practice thinking in reframing information quality management, information management and data compliance, and data quality for field process excellence. Poor data quality impacts on businesses in many ways; it can reduce the responsiveness of customer services, increase costs due to duplicate or incorrect processing, it may even cause system failure. High profile stories of the impact of poor data quality abound, from the incorrect charging of bank customers to the loss of billion euro space vehicles. The IQ Network will educate its members on the latest processes and technologies used to combat inefficient data and information. It will provide a platform for like-minded individuals and it will support members' efforts in driving improvements in information and data quality management throughout Irish organisations. Further information can be found at www.computing.dcu.ie/iqireland.

CERN — **World's Largest Computing Grid Surpasses 100 Sites**. The Large Hadron Collider Computing Grid (LCG) project (see article in ERCIM News 59, page 18) announced that the computing Grid it is operating now includes more than 100 sites in 31 countries. This makes it the world's largest international scientific Grid. This Grid is being established in order to deal with the anticipated huge computing needs of the Large Hadron Collider (LHC), currently being built at CERN near Geneva, Switzerland. The sites participating in the LCG project are primarily universities and research laboratories. They contribute more than 10,000 central processor units (CPUs) and a total of nearly 10 million Gigabytes of storage capacity on disk and tape. This Grid receives substantial support from the EU-funded project Enabling Grids for E-science (EGEE), which is a major contributor to the operations of the LCG project.

CNR — **An agreement has been signed** by Dr Volker Liebig, Director of the Earth Observatory of the European Space Agency (ESA) on behalf of ESA and by Dr Paolo Prefetti, President of the CNR Research Campus Tor Vergata, Rome, on behalf of CNR for the development and use of Grid technology. A three-year collaboration is planned which includes the completion of the optical fibre network between the European Space Research Institute (ESRIN) and CNR Tor Vergata, essential for the sharing of data and computing resources in earth science projects and applications. ESA-ESRIN and CNR also participate in the Megalab project (Metropolitan e-Government Application Laboratory) which aims at setting up a new high-speed data link from the centre of Rome to Frascati, linking numerous research institutions in the area into a Metropolitan Area Network (MAN). This network is seen as a way of boosting regional competitiveness and offering innovative e-government services, enabling Grid computing for science and also business.

ERCIM – The European Research Consortium for Informatics and Mathematics is an organisation dedicated to the advancement of European research and development, in information technology and applied mathematics. Its national member institutions aim to foster collaborative work within the European research community and to increase co-operation with European industry.

ERCIM is the European Host of the World Wide Web Consortium.

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